Britain's Most Advanced Magazine

4 FLASH IC PROBLEM
48 53

PRACTICAL NEW ELECTRONICS
SCIENCE AND TECHNOLOGY
September 1992 • £1.50

Electronic Imaging

The Truth About Image Manipulation

Calling The AA

Philips' Widescreen

Ascom Phone

Plus

Worldwide TV
The Multi-instrument
Microscopic Motors
Image Compression
Sony's Latest Palmcorder
AT&T's Colour Videophone

Opinion

Barry Fox with an inside view on the MOD
Ian Burley on how to save money with new bulbs

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This month...

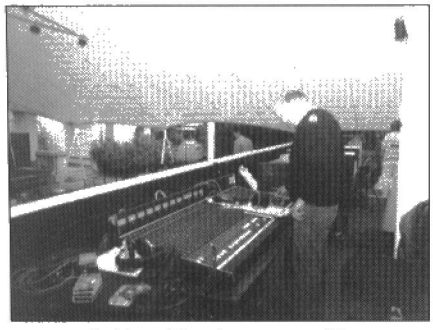
Two articles that may not seem connected at first sight are Barry Fox's column and the feature on computerised photo-manipulation. Couple these with the recent moves by the courts to accept photographic evidence for traffic law violations and things get a little clearer.

The idea that a photograph is incontrovertible evidence is now a fallacy and for courts to accept them as such could be quite dangerous. Obviously, one hopes that no faking could ever occur but whenever things are possible, they will almost certainly happen – at least once.

Unfortunately, it may not be good enough to be aware that electronic picture editing can happen. The trouble is that it is difficult to spot and impossible, to regulate the technology.

Kenn Garroch, Editor

Combined Instrument – page 45



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Out On 3 September

Cover illustration and design: Kenn Garroch (with help from Carolyn Vaughn)

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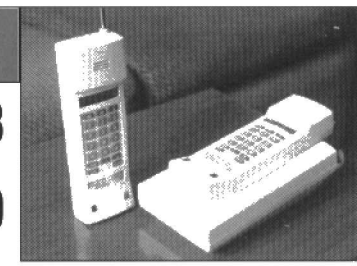

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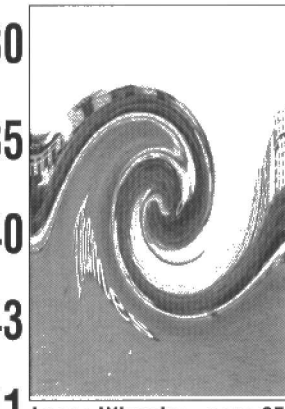

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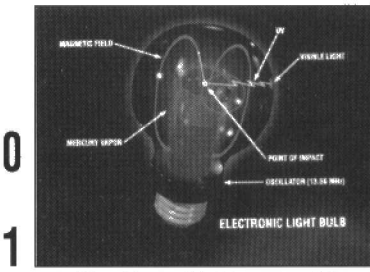

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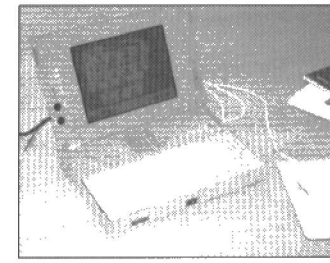

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Innovations

A roundup of the latest happenings in the wide world of electronics, science and technology.

Flash Cards

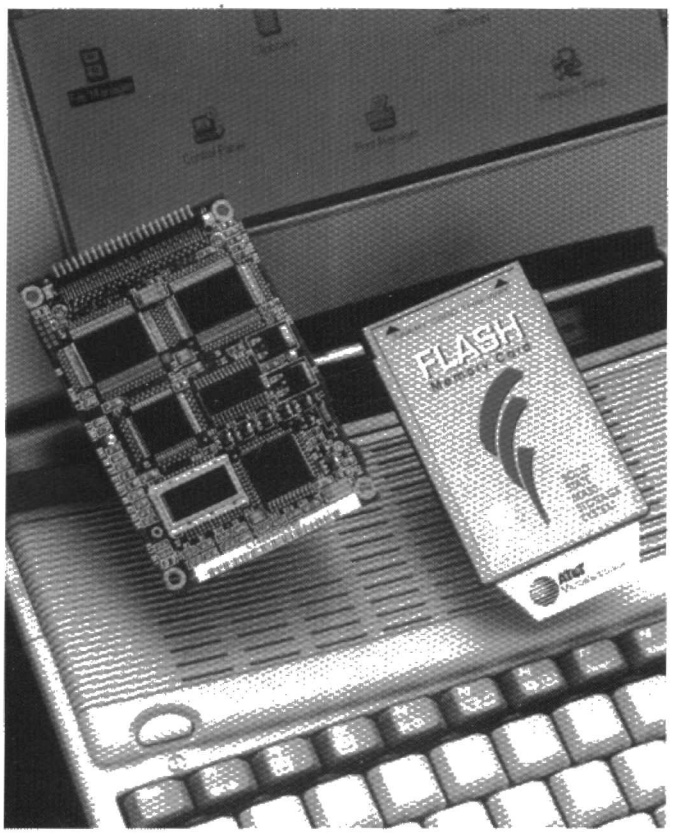
AT&T in association with Sundisk has launched its bid for the flash memory market. Designed as a direct replacement for 2.5in disks, the IDE series of credit card sized storage devices offer capacities of 2.5, 5, 10 and 20Mbytes. A single controller can accommodate two flash cards giving a total maximum capacity per system of 40Mbytes.

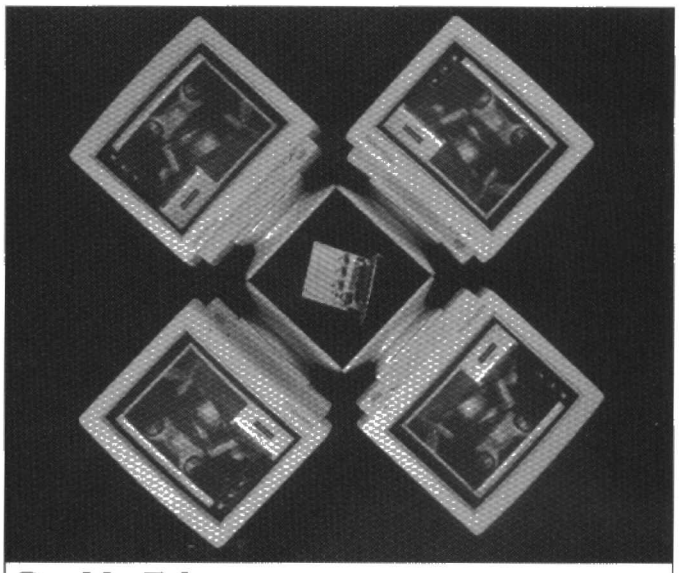
The IDE cards have three times the mean time between failure (MTBF) of conventional hard disk drives while using less than a third of the power on a single five volt supply. The cards use AT&T Microelectronics' 4Mbit and 8Mbit flash file devices. These operate in a similar way to magnetic disks in that they produce a serial output and are organised as 512 byte sectors.

The Sundisk interface system incorporates wear levelling and the spotting of bad sectors. This gradually shifts frequently modified or re-written data from sector to sector. The drawback with flash memory devices is that they have a limited number of write cycles. The advantage of the AT&T chips is that, with small sectors, the loss of a few of them does not immediately mean the card becomes useless.

Sundisk and AT&T are currently designing a 16Mbit flash file chip which should extend the capacity of the IDE card drives to 80Mbyte by the end of 1993.

AT&T Admail 4 International, Greatness Lane, Sevenoaks, Kent, TN14 5BQ, tel 0732 460424.





Double Take

Scene Double has just launched an adaptor card for an IBM PC type computer that will allow it to drive up to four Super VGA monitors at once. The SD2+2 is a quarter length card that will drive the host monitor plus three others. The addition of an extra card linked to the first will allow the system to drive a total of eight displays. Priced at £249+VAT the cards are aimed at PC training organisations, monitor manufacturers, educational establishments and retail/exhibition displays.

Scene Double, 2 Glendale Avenue, Edgewave, Middlesex, HA8 8HG

New Memories

Ferroelectric RAM is a type of non-volatile memory product that will soon be available as a replacement for EPROM and battery backed RAM.

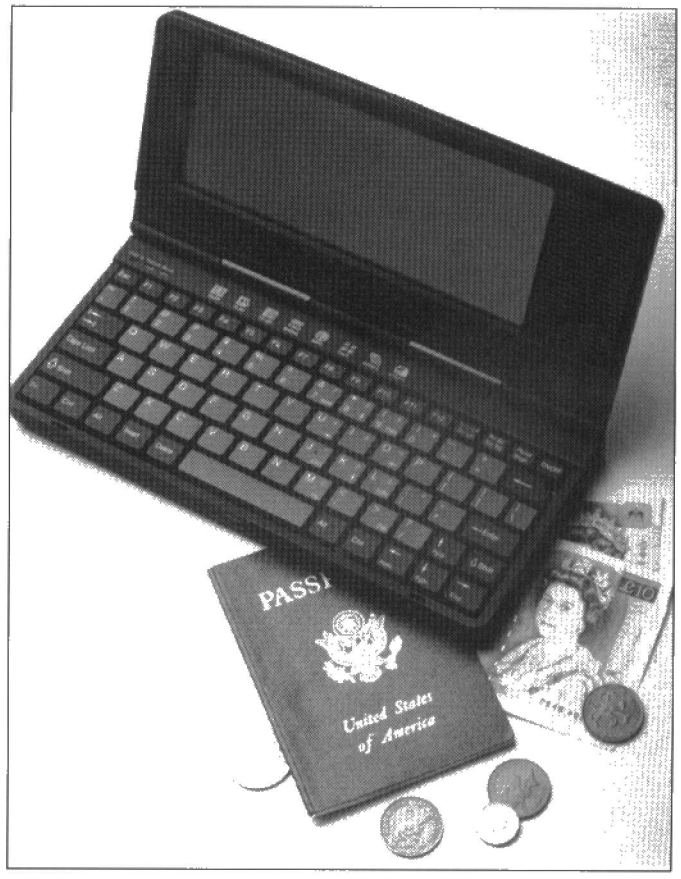
FRAMs use the ferroelectric effect which is the tendency of magnetic dipoles within certain types of crystal to spontaneously align in parallel (polarise) under the influence of an externally applied electric field. They remain in this position after the field has been removed and their direction can be reversed by the application of the opposite electric field. Because no external field is needed for the dipoles to remain polarised, the device is non-volatile and should retain its data for 10 years. Information stored in this format can be read by sensing the interaction of an applied

Radius Videovision ▲

Videovision

Radius, best known for its Apple Macintosh display and accelerator technology, has entered the growing multimedia market with Videovision. This enables the computer to take in video from either PAL, SECAM or NTSC and match it up with sound and a combination of computer generated graphics and scanned stills. The resulting sequence can be output to standard video tape in high quality S-VHS format.

Based around a single NuBus card, Videovision provides an external connector panel which allows a number of video and sound sources to be transferred to and from the computer. Radius, 1710 Fortune Drive, San José, CA 95131-1744, tel 408 434 1010, fax 408 434 0127.

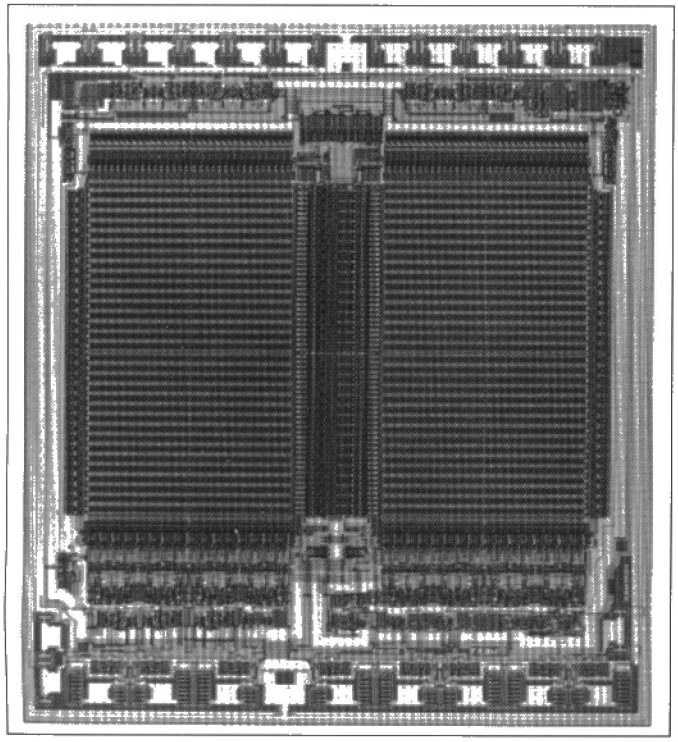


Light-weight PC

The latest entry into the pocket PC market comes from Zeos. Its new design weighs in at 1.3lbs and measures 9.25inx4.5inx1in. With 1Mbyte of RAM, two PCMCIA slots, 640x200 16 greyscale screen, qwerty keyboard and bundled MS-DOS 5.0 plus Microsoft Works, the Zeos should cost around $595. Battery life is rated at around 10 hours under continuous use and is supplied from two AA batteries.

Zeos Sales, Zeos International Ltd, fax 612 633 1325.

The ferroelectric RAM ▼



field with the elements polarisation.

FRAM memory is built by replacing the conventional capacitative element in a standard dynamic RAM circuit with a thin film ferroelectric device. The first device to be put on the market, the FM1208 is organised as 512x8 bits and operates from a single +5V consumes 44mW and has an access time of 250ns.

For more information, contact:

Ramtron, 1850 Ramtron Drive, Colorado Springs, CO80921, Tel. 719 481 7000, Fax 719 481 9170.

■

Wavelengths

If you have any comments, suggestions, subjects you think should be aired, write to PE

Meteor Scatter

I found the article by Ian Poole, in the June issue of PE, about meteor scatter radio transmission most interesting. One lack, however, was that there was no mention of manufacturers of such equipment. Can you help?

T Grafton
Kingston
Surrey

Ian Poole replies:

Most meteor scatter equipment is manufactured in the USA. Perhaps the following list will be of some use:

Racal Communications Ltd.
Meteor Communications Corporation, Kent, Washington, USA
Hadron Inc, Chantilly, Virginia, USA
Scientific Radio Systems In. Rochester, NY, USA
Napco International Inc, Hopkins, Minnesota, USA
IA Research Corporation, Delray Beach, Florida, USA
Vaisala Oy, Helsinki, Finland

Marconi, Rhode & Schwartz and Watkins Johnson, who all have IEPS or bases in this country, probably also have some meteor scatter equipment as well.

Controlled Plea

In the early 1980's British electronics led the world in digital control systems for model railways. Namely the Hornby Zero-1. Led by electronics designer Mr. Lucien D'Sa, a team developed and manufactured a world class system which, even today 12 years later, can equal new generation models by other manufacturers. Zero-1 is based around the TMS1000 IC from Texas Instruments.

In 1983, the design team was disbanded by Hornby and production also ceased. Development of the system was at what was known as Phase III (mimic, console, etc.). Unfortunately, no information is available to complete Phase III functions (keypads, etc. which were already built into the mimic console), and allow the full potential of Zero-1 to be shown. It is disappointing that after such a great start the electronics innovation was stopped.

Can any person involved with the design team assist in giving details of the unfinished Phase III functions? This will allow many users of Zero-1 to fulfil the capabilities of British electronics innovation.

Please write to:
C Harris
10 Patea Place
Palmerston North
New Zealand

Colour Please

Your coverage of the multimedia market and the new products therein is very commendable. One drawback is the lack of colour – the autodesk 3D picture shown in the August issue looks quite stunning in colour. I know it costs more but is there any chance of colour in PE?

W Hawthorn
Edinburgh
Scotland

Your wish, as they say... Ed

Ee, What A Lamp

I noticed your coverage of the E-Lamp in the August issue of PE. The artists impression is close but not quite right. As a magazine that tries to bring us the latest information on the world of electronics, I think you could have done your research better.

P Bright
Brighton
Sussex

Intersource Technologies, the manufacturers of the E-Lamp, were rather slow in getting us the latest information about their invention so we had to take a guess. The official picture is shown on page 11.

Electronic PC

I want to buy a new computer but am a little spoilt for choice. I am writing to you rather than a computer magazine because, as an electronics magazine, you might have a different slant on things.

As well as using the PC for all of the usual functions of wordprocessing, windows, databases, spreadsheets and, of course, games, I want to be able to interface it to the outside world and use it to control things. Is there one machine that would suit me better than another or are they all much of a muchness?

K Smith
Chester
Cheshire

There are a large number of bargains to be obtained in the PC market at the moment. Everybody seems to be cutting their prices to get rid of their machines. To run the software you want, you will probably need at least an i386 microprocessor, preferably running at 25MHz. Get the largest hard disk you can afford and look for something that has an SVGA monitor thrown is as well as a printer (if possible) – the best place to look for machines is in the 'ad-thick' computer magazines.

From the point of view of interfacing to the real world,almost all PCs are able to do this with the appropriate add-on card. The thing to make sure of is that there is plenty of space to fit the cards and that they are easily accessible. Tower systems are usually easier to deal with in this respect. A good source of information about interface cards can be obtained from National Instruments UK, 21 Kingfisher Road, Hambridge Court, Newbury, Berks, RG14 5BR ■

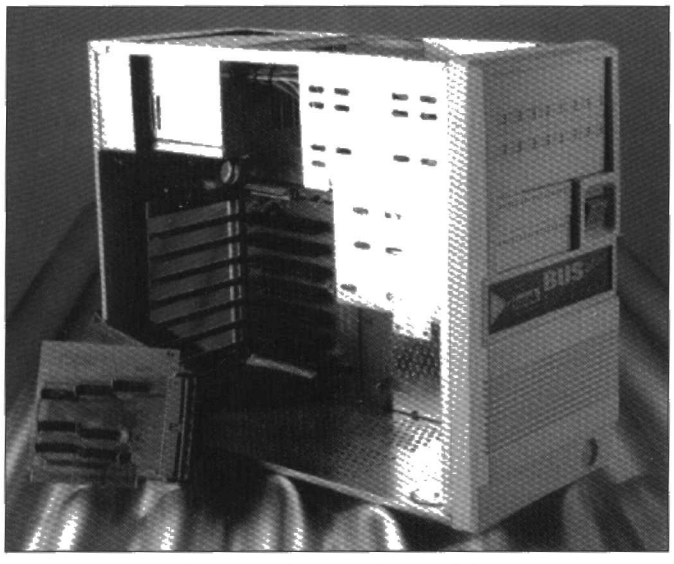
Computing News

The latest from Anthony Robertson

More Slots

As PCs become smaller they are often equipped with fewer slots, yet many applications need several add-on cards to function satisfactorily. To solve this problem Intek have developed the `Bus Plus'.

The device is a complete stand alone mini-tower with its own case and 200 Watt power supply. Currently the design only allows for the connection of



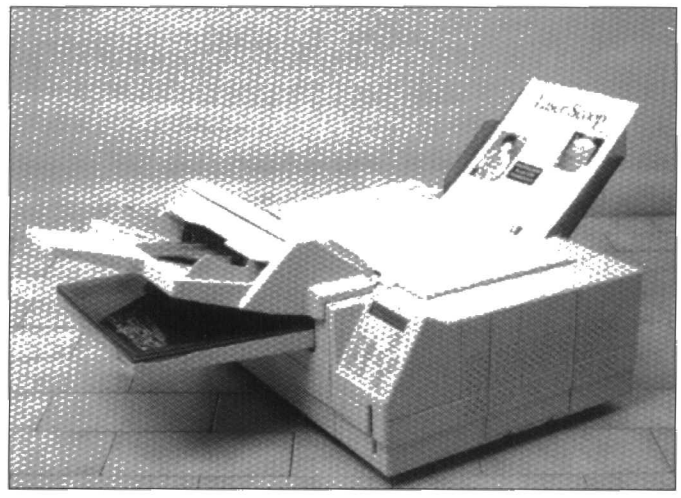
Add those important extra slots

8-bit devices, but there is also space for two 3.5" and two 5.25" disk drives. This makes it ideal for use with portable and laptop PCs, which have at least one 8-bit expansion slot, to create a `base station'. For more information please contact Intek on 0352-85603.

Future Proof

Computer equipment bears high prices and ever diminishing second hand value. This could possibly be attributed partly to planned obsolescence, so necessary for maintain corporate cash flow, and the incredible speed at which computer technology develops. Every month sees new and faster designs – all offering increased productivity and more features. It is not uncommon for equipment to become obsolete in weeks rather than years.

Ricoh redress this balance with a unique new laser printer, the Ricoh LP1200. Fully compatible with PCL5 and the de facto standard in laser printing, HP LaserJet III compatibility. It features 2Mb of RAM, printing speeds to 6 pages per minute and 400 DPI (dots per inch) resolution.



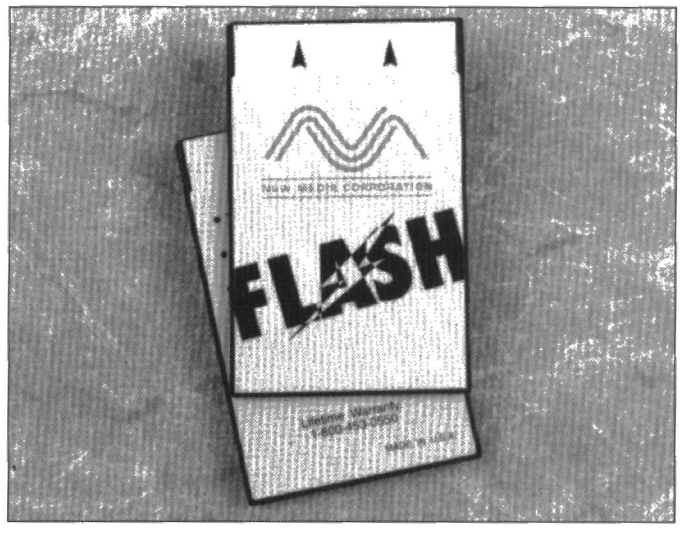
Future proof, yet only £699 now

More importantly the LP1200 has in-built "future proof technology". Internal FLASH ROM will enable users to upgrade to the latest version of printer command languages as soon as it is released - this is one printer that will retain a high second hand value as it cannot become obsolete. For more information please contact Silica Systems on 081-309-1111.

Frugal Flash

Flash RAM has been promised as the next step up from conventional and slow hard disk storage. Unfortunately, high costs have prevented this from becoming a reality.

Now the tables have turned with the announcement from New Media Corporation (USA), of an innovative range of IC cards for use in sub-notebook and palmtop personal computers equipped with PCMCIA interface slots which are rapidly becoming the standard.



Flash cards, a cheap alternative.

The size of a credit card, NMC's new Publish Cards are available in capacities from 256k up to 100Mb. More importantly, costs can be as little as $10 per megabyte in comparison to nearly ten times more for the equivalent storage available from SRAM cards. For more information, please contact Simon Harvey at NMC on 0101 714 453 0100. ■

Barry Fox

When is a secret not a secret? Barry asks the MOD.

We are told that the British government wants more open government and less unnecessary secrecy. Anyone who believes that line should do as I sometimes have to do, and try phoning the Ministry of Defence to check a story.

Recently I heard that the MOD's Research Agency in Farnborough had been working with a British company, Pearpoint of Bordon in Hampshire, on a covert night surveillance system for reading the number plates of cars without their owner's knowing. This news coincided with the change in law which now allows photographic evidence of motoring offences to be used in court.

Currently the police either take still photos with a fixed camera and flash gun triggered by a radar speed sensor, or they use a video camera in an unmarked car which tails the speeding motorists and electronically combines the image of the police car's speedometer with an image of the number plate of the car ahead. Neither system lets the police or security forces watch either parked or moving cars at night, without the driver knowing.

This is what the MOD's new toy can do. But when I phoned for information all I got was the standard secrecy line.

"If it's to do with surveillance then obviously we don't want to talk publicly about it. But we will check with Farnborough and get back to you".

Several days, and several reminders later, the MOD at Farnborough finally got back to me. They sent me some largely irrelevant and very superficial bumph about MVTA (Machine Vision Transputer Array System). This system, which was developed by the Defence Research Agency at Malvern, uses transputers and unspecified software to recognise characters from a photograph of a car number plate in around 1 second. In other words it's an Optical Character Recognition system. There was no mention of how it worked or of the vital missing link - how to photograph a number plate at night, if necessary without the driver or passengers knowing.

Fair enough, you may well say. It makes sense for the MOD to keep its surveillance tricks secret. But not so in this case.

The MOD had already published full technical details of its surveillance system in a British patent application (number 2 248 994), for anyone, anywhere in the world, to read. The Ministry of Defence is itself responsible for vetting all patent applications filed at the British Patent Office, but had allowed its own documents to pass through the system without any delay.

Reading vehicle number plates at night in a covert manner has long been a problem, explains the MOD's patent frankly. People under surveillance seldom park conveniently under street lamps and any attempt at beaming light on the number plate gives the game away. Although it is possible to read the number plate with infra-red illumination and a camera sensitive to infra-red, people under surveillance have learned a simple trick to beat the system.

They just switch on their vehicle headlights to overload the sensor. The only way then to read the plate is to radiate an intense beam of infra-red light. But the only way, so far, to radiate an intense beam has been to put an infra-red filter over an incandescent lamp. People with good eyesight, who know what to look for, will spot the beam source.

The MOD's new idea is a trick in several stages.

Instead of generating the infra-red light by filtering an incandescent lamp, the light source is made up from several hundred light emitting diodes, each of the type used singly in the remote control for a TV or video recorder. These LEDs generate longer wavelength infra-red, of up to 1000 nanometres, which is invisible to the human eye. But, even ganged together, 400 LEDs cannot defeat the dazzle from car headlights.

So, instead of feeding a continuous supply of electricity to the LEDs, the ganged array is fed a rapid stream of very short pulses. The LEDs can then handle ten times their normal safe capacity of 100 milliamps, and briefly radiate ten times the light they can radiate if used continuously. The MOD favours pulses of around 1 millisecond or less.

The infrared pulses are timed to coincide with the operating speed of a video camera. Whereas a conventional video camera shoots 50 pictures a second, each of 20 millisecond duration, the MOD's camera is modified to shoot 50 pictures a second, each of 1 millisecond, or less.

The brief exposures of the camera are exactly synchronised with the brief pulses of the LEDs. When the camera is only shooting for 1 millisecond instead of 20 milliseconds, it only receives one-twentieth the light it would normally receive from the headlights. But in that single millisecond it is receiving the full dose of infra-red light beamed from the LEDs and reflected by the number plate. So the IR swamps the headlights. Reducing the pulse and exposure time even further, makes surveillance even easier.

To increase sensitivity yet further, the camera lens is covered with a filter which passes mainly infra-red light, and rejects light of other wavelengths.

Because number plates in the UK are made to reflect light back in the direction of its origin, like cats' eyes in the road, the infra-red light can be focussed into a very tight beam and placed very close to the camera. This, and the long wavelength of the light, makes it very unlikely that anyone under surveillance will see a tell-tale light source. The patent application describes a camera made by Pearpoint which has motorised focussing to ensure a crisp image of the number plate. The designers believe that the infrared source and camera can be packaged in a cube just ten centimetres square, and powered by a 12 volt battery.

The system can be used either to catch criminals and terrorists or catch speeding motorists, without their knowing. The mystery is why the MOD should publish such full details of such a clever system, thereby letting surveillance subjects devise some pretty obvious counter-measures, and then pretend it is secret.

Could it just be another case of the left hand of the security service not knowing what the right is doing? ■

Ian Burley

No go for green lights?

Take a car which, on average, does four times the mileage to a gallon and produces four times less pollution without sacrificing performance. Then add the fact that servicing would only be needed once or twice in its lifetime. Products offering similar benefits would be an overnight best sellers. Or would they?

Sadly, in the case of the long-life energy-efficient light bulb, the answer so far is no. Reasons for its commercial failure are varied – some convincing, others less so. Energy efficient compact fluorescent lamps (CFTs) should be more accepted but instead it could be left to the new E-lamp from InterSource Technologies in the US (New Product Developments last month) to give 'green' lighting a second chance.

The common or garden light bulb has changed little, fundamentally, since it was invented by Thomas Edison in 1879. In this age of energy conservation and anti-pollution, the good old light bulb should be an anachronism, yet there is little to suggest that its popularity has yet been dented.

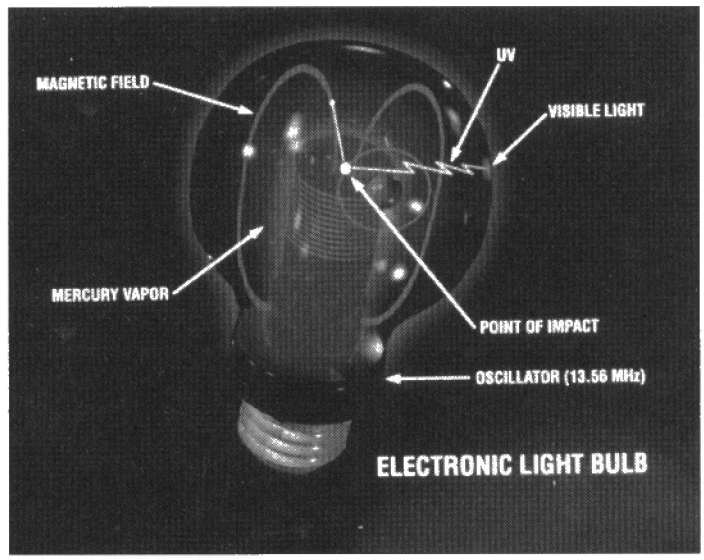
CFT bulb alternatives have been with us since the late eighties. CFTs offer, an average life span eight times that of a conventional incandescent light bulb and less than a quarter the power consumption for the same brilliance. Sounds good – so what's the catch? There is an ominously long list of reasons.

Firstly, CFTs aren't cheap – they cost upwards of £10 each compared to 60p for an equivalent bulb. CFTs have a bulky base containing a choke starter, just like more conventional fluorescent strip lighting. Incidentally, switching a fluorescent lamp on and off frequently can be wasteful too as the starter requires a lot of power to fire the tube up. CFTs aren't aesthetic prize-winners, especially matched with the latest in designer lampshades. And you can't get romantic under one of these lamps – dimmer switches are a no-no.

CFTs are not easy to buy; a quick scout around my town only revealed four outlets which could sell me one. One was an electrical supplies shop, another was a supermarket and the third was Woolworths. The fourth was the local electricity board shop, but there I had to get the shop assistant to delve into the store room to actually prove they had any. "We don't get much demand for these," the assistant replied when I asked why they weren't on display. Two years ago the same shop told me CFTs weren't stocked at all. My search for CFTs in other obvious outlets like B&Q DIY, Texas DIY and three other supermarkets, was fruitless.

The potential energy saving of these lamps certainly adds up, eventually. My modest abode has six main 60 and 100 watt lights. At today's prices, I estimate these lamps would burn about £22 worth of electricity in a year compared to a fiver's worth with CFTs. However, I'd have to wait around three years to recoup the overall cost of buying six £10 CFTs. But in the mean time, the three years worth of wasted electricity adds up to almost a megawatt/hour and goodness only knows how much generator pollution. In the same period two or three of the original lamps would have blown so the replacement costs and associated inconvenience should also be accounted for.

I question some of the reasons why we baulk at buying CFTs. How many of the lights in a house are controlled by dimmers? Are stylish lamps essential for everywhere? Buyers, me included, have been put off by the initial purchase cost. But is the cost that much really and why are they so expensive in the first place? A CFT costs less than a meal at a decent restaurant. Today a bulb blew on my landing – tomorrow I'm going to buy my first ever CFT! I could take a tenner out of a building society account and probably save as much as the interest lost.



High initial CFT manufacturing costs can't be reduced until volume sales are reached. This ideal will never be achieved until the public is more aware of the long term benefits and perhaps the pricing was subsidised. I wouldn't award lamp manufacturers, or the government for that matter, any prizes for promoting CFTs. In the US, local electricity companies and the government have actively provided inducements to switch to CFTs.

I'm probably one of many suspecting the influence of vested interests. Not much effort seems to have gone into the continued development of CFTs – I'm sure they could be at least made to be more compact and look more stylish. Then there's the suggestion that a quirk in fluorescent tube technology means that while consumers can reduce electricity costs, measured in watts, by 80% – local electricity companies only save 50% as their supply is costed in amps.

It is unlikely the CFT will never be the true successor to Edison's incandescent light bulb. Instead, InterSource's new high-tech E-lamp could be Edison's heir – it is cheaper to make, actually lasts longer and is much more efficient. It can also be dimmed in the normal way and promises to be less bulky. However, don't expect to see E-Lamps on sale for a couple of years yet. There's currently a worry over radio frequency (RF) interference – which InterSource refutes, incidentally. So by the time E-Lamps probably get to the UK market, my new CFT will probably have paid for itself. ■

I Spy Something Beginning With A

Ian Burley looks at the latest portables from Acorn and Amstrad, the AA's much advertised callsafe system and Philips' latest widescreen TV.

This month's look at new product developments has a distinct computer flavour about it. We look at two new portable computers at totally different ends of the spectrum as well as a computer mouse which has legs rather than a ball. We also investigate the new AA Callsafe cellular phone package and Philips' cut-price widescreen TV.

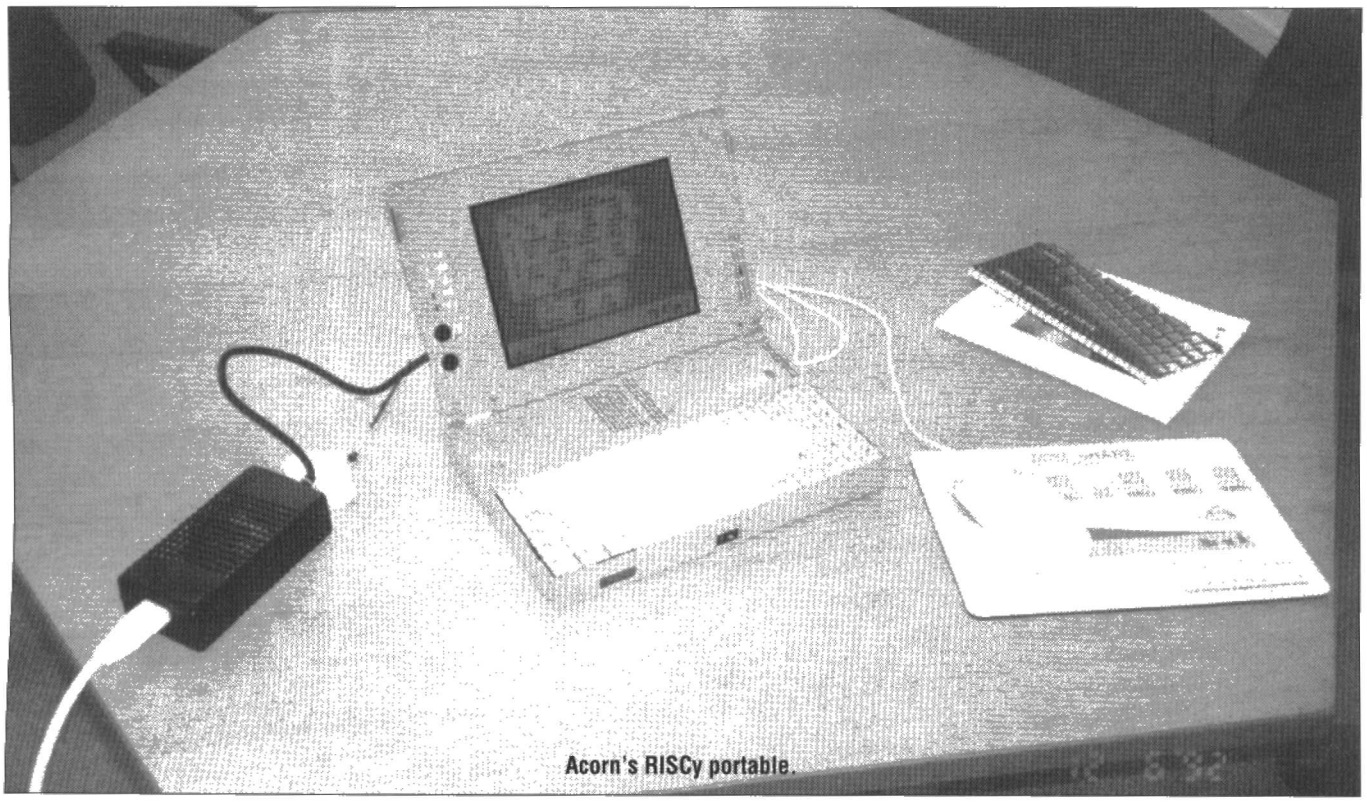
Acorn In The Shade

Not a lot of people know that Acorn Computers, better known for the BBC Micro which dominates computing in schools, designed the world's very first commercial RISC (reduced instruction set computer) microprocessor. That was way back in 1985. The chip became known as the ARM (Acorn RISC Machine) and was first used in Acorn's Archimedes desktop computer in 1987.

Just a year later, Apple realised the ARM's low power consumption and efficient design made it ideal for portable computing applications. Four years on and a month after Apple announced its intention to use the ARM in advanced new portable products called Newton Personal Digital Assistants, Acorn itself has joined the portable computing set. The result is a notebook sized computer called the A4 – which is also the size of its 'footprint'.

Acorn's A4 isn't the first RISC powered notebook computer. Another British company, Tadpole Technology, beat Acorn to that accolade some 18 months ago by producing a notebook PC containing a Sun Microsystems Sparc RISC processor. Nevertheless, the A4 is technically interesting in its own right.

The A4 uses an ARM3 variant of the basic ARM RISC chip clocked at 24MHz and rated at 12 million instructions per second (MIPs). This has been used for a couple of years already in other Acorn computers and is roughly equivalent to an Intel 486 processor in performance. ARM3 is old technology compared to the ARM610 Apple will using. The later chip is 40% faster, uses even less power and is more compact. However, Acorn stuck with



Acorn's RISCy portable.

Amstrad's NC100 is reminiscent of the famous Z88

the ARM3 because its proprietary operating system isn't yet able to exploit the advantages of the new ARM6 generation of RISC chips now being produced by spin-off company Advanced RISC Machines Ltd (ARM Ltd).

However, there is some new chippery inside the A4. Acorn had to develop its own custom chip to interface its VIDC video controller chip with the LCD screen. Acorn has applied for patents covering new techniques used in the chip. Interestingly only 15 grey-shades are displayed on the screen instead of the more normal 16 featured by other notebook PCs. This is because two VIDC generated colours, which would look different on a colour monitor, have the same grey values on the LCD screen.

Olivetti, Acorn's parent company, has obligingly supplied a nice flock-effect finished notebook case which is also used in Olivetti and Triumph Adler notebook PC models. Sadly there is no built in mouse pointing device as the touchpad arrangement in the PC versions was dropped by Acorn. Instead you get a Logitech mouse.

The rest of the A4's specification fails to match that of its innards. There is no bus expansion facility so no fancy cards can be fitted. You won't find any PCMCIA mini-expansion card slots either, or an internal modem slot for that matter – all these things are rapidly becoming standard features in decent PC notebooks nowadays.

The A4 is a confusing contrast of high-tech RISC-powered performance in a dated and conservative package. At £1699+VAT for the main model with 4Mb RAM and a 60Mb hard disk, the price is reasonable for the computing power on offer, but there are doubts Acorn's traditional education customers can afford it even with a £300 education discount. Acorn could have unveiled the A4 several months ago, instead it was rolled out a month after Apple's Newton showed what can really be done with basically the same building blocks.

Acorn: Tel. 0223 245 200

Z88 Revisited

It's slimline, black, battery powered, has a letterbox LCD screen, operating system, utility software and BBC Basic in ROM, but isn't a Cambridge Computers' Z88. It's Amstrad's new Notepad NC100 portable computer, which the company claims is 'the world's easiest to use computer'.

Amstrad says it is so confident of the claim, its £3 million NC100 promotion challenges customers: "If you can't use an Amstrad Notepad in just 5 minutes, you'll get your money back." This comes from the company owned by Alan Sugar who was recently quoted as saying that the customer wasn't always right!

It's difficult to avoid comparisons with the Cambridge Computer Z88, launched by Sir Clive Sinclair back in 1986. At a glance they might look identical, although the NC100 has a proper keyboard compared to the Z88's 'dead flesh' rubber design and several NC100 keys sport bright colours to liven up the otherwise sombre black facade.

Internally, the feeling of deja vu continues; A 6MHz Z80 processor replaces the Z88's 4MHz version. There is no built in disk drive. The Z88 pioneered removable memory cards and the NC100 has one PCM-

CIA mini-card expansion slot which can cope with up to one megabyte of memory to supplement the on-board 64K of low power static RAM. Amstrad says four standard alkaline AA penlight cells will power the NC100 for up to 40 hours. One thing the Z88 cried out for was a fail-safe battery back-up and the NC100 has it in the form of a Lithium cell.

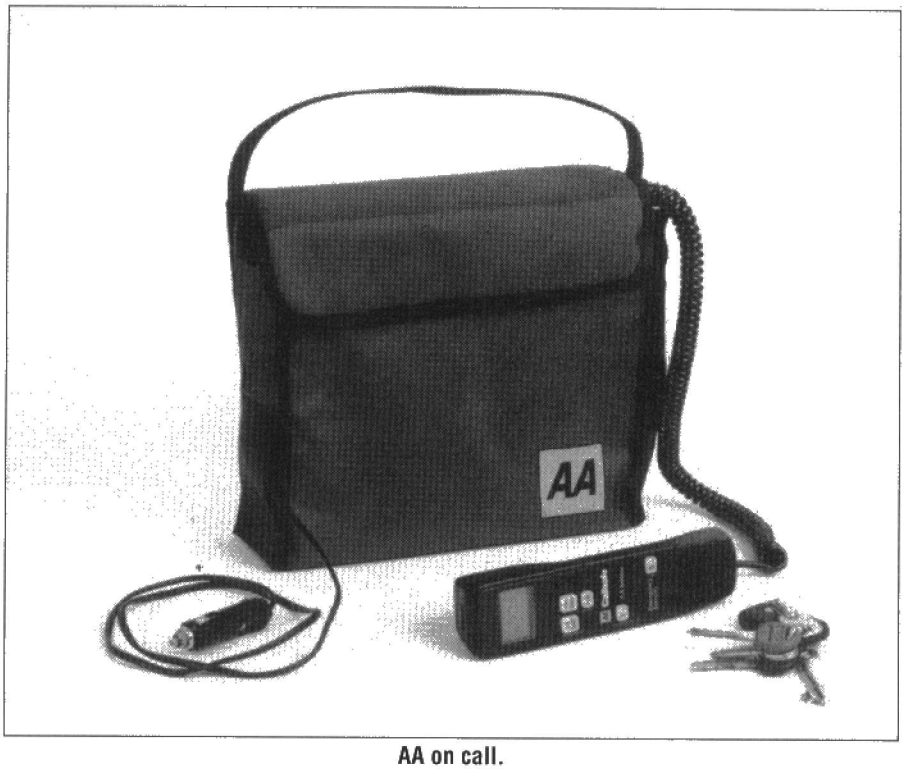
The NC100's narrow blue-tint LCD screen looks like it was lifted straight out of the Z88, which would be no bad thing as at the time the Z88 had the sharpest screen going. A usable graphics resolution of 480 by 64 dots is provided by the screen. This translates into eight lines by 80 columns for, say, a word processor display. On the other hand the built in calculator mode uses the whole display as a jumbo-sized numeric read-out.

Amstrad's ease of use claim stems from the simple use of icons and 'hot-keys' – the latter heavily used by the Z88. You can be ready to start typing into the word processor with just two keystrokes. Although I haven't had a chance to play with a NC100 yet, it doesn't appear that the Z88's ambitious windowed context-switching user interface has been emulated.

Built in software includes a word processor with 48,000 word spelling checker, address book, calendar/diary, alarm, calculator and the BBC Basic programming language. The latter is a clear sign that Amstrad has eyes on the education market which embraced the Z88 with great enthusiasm. Besides schools, Amstrad says it is targeting the 80% of the population which still hasn't come to terms with modern personal computers.

The NC100 can exchange files with a PC via an optional PC connector and , theoretically, it could be a big seller for Amstrad – unlike the Z88 which had rave reviews but was a commercial failure with less than 100,000 sold in six years. Cambridge Computers still sells Z88s in small quantities, but most of the company's efforts these days are directed at the satellite TV dish/decoder market.

Amstrad's undoubted marketing skills might endow the NC100 with the success the Z88 deserved. The NC100 is priced £199.99 including VAT. For more information contact Amstrad on Tel.0277 228 888.



AA on call.

Different Mice

It came as something of a surprise to me that Honeywell, the US computer manufacturer, had a keyboard manufacturing division – usually these low-tech add-ons are built in countries where labour is cheap. I was also surprised to find that the company has been developing a mouse pointing device for PC users using some intriguing alternative technology.

Conventional computer mice contain a plastic or rubber-coated ball which is rolled around as the mouse is moved on a suitable surface. The ball drives a pair of wheels at right angles to each other so generating X and Y positioning co-ordinates. Opto-mechanical mice use a slotted wheel through which a light shines on to a detector to detect pulses which can be interpreted by mouse driver software.

Instead of a ball, Honeywell's mouse uses a pair of feet carefully angled and aligned. This arrangement was invented and patented by Jack Hawley, one of the pioneers of mouse design, in the 1970s. Honeywell decided to use the Hawley mechanism because it's less prone to the build up of dirt, is less fussy about the type of surface it operates on and can work at any angle, even upside down. There are also less mechanical parts which should make it more reliable in the long term.

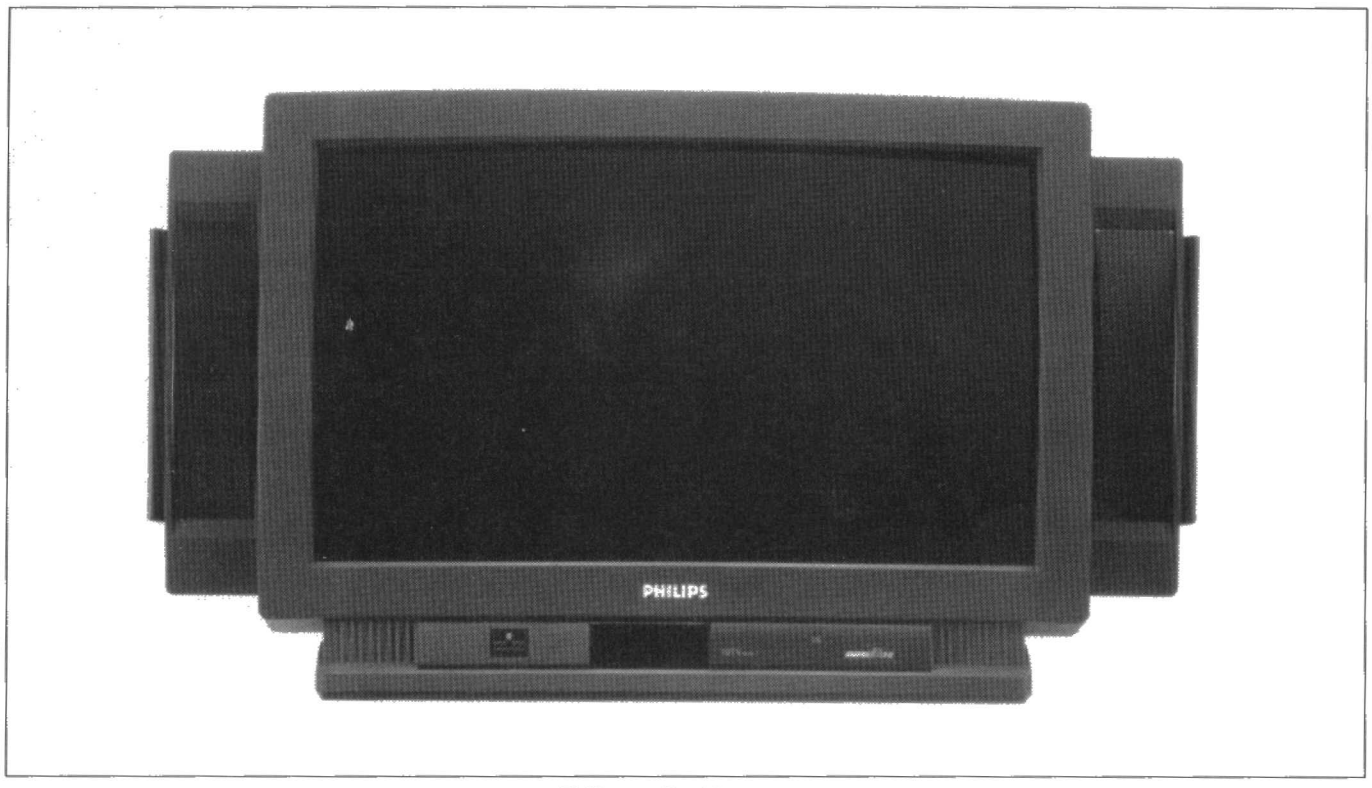
Basically, each 'foot' is an axially inclined shaft with a wheel at one end in contact with the working surface. The Honeywell mouse is an opto-mechanical device like a conventional mouse so at the other end of the shaft is an optical sensor for generating pulses X/Y coordinate pulses. Rather than a slotted wheel, the detector uses a slotted drum through which the infra-red LED shines onto the photodetector. A magnetic traction assembly constantly applies a force on the shaft to ensure good contact with the working surface – at any angle.

Honeywell's Hawley mouse has a resolution of 320 dots per inch and is available two or three button versions. For more information contact Honeywell on Tel.0344 416 034.

The AA Plays Safe

The Automobile Association has got together with Vodafone, the cellular phone operator, to produce a package aimed squarely at people who fear being stranded in their car in a strange place far from a convenient phone box.

For your £200 plus one-off £35.25 joining fee you get a modified transportable cellular phone which the AA says is small enough to fit under a car seat until it is required. The Callsafe handset doesn't have full complement of



Philips on the big screen.

keys – it's not designed to let you make ordinary phone calls to anybody you like. Instead you can dial 111 for the AA's rescue services or the national emergency 999 services. After you've made contact with any of these services they have the facility to phone you back if necessary. As the Callsafe phone is transportable, it can be used in different cars, including rental cars. Power is normally provided via a car cigar lighter or an optional battery pack.

Specialist markets seem ideal for Callsafe. Disabled drivers might not be able to get to a phone outside their car easily, for example. Apparently parents are attracted to the security of knowing their children will be safe driving alone. The AA quite unashamedly targets women drivers. But why not just get a full-blown standard cellular phone in the first place?

The AA points out that its £10 monthly charge is substantially less than the average £25+VAT monthly charge for an ordinary cellular phone. I suppose the fact that you can't run up costly charges phoning your friends could be described as a plus point too. Then again, they can't ring your CallSafe phone either. The cost argument begins to look weak when several air time providers (ATPs) are already offering discounted monthly charges for fully-functioning phones. For example, the cellular phone division of Ford, the car maker, already offers an optional £10 monthly charge, but in return for much higher call costs up to 69p a minute. Vodafone itself is rumoured to be unveiling a cheap rate service for domestic users offering low cost off-peak calls and a low monthly charge.

It's difficult to predict the take-up of a product like this. Callsafe's simplicity is likely to be an attraction, but overall I find it hard to see any crucial advantages over something like the Ford offer.

One interesting Callsafe option is a vehicle location device using radio or satellite tracking technology.

The AA: Tel.0256 20123

Cut Price Widescreen

Philips has just introduced its most affordable widescreen TV yet. Hot on the heels of Nokia which announced a £1100 28in16:9 aspect ratio TV recently (PE June 92), Philips has introduced its own 28in 16:9, the Matchline 8916, with a recommended price of £1299.99. This about half the price of Philips' original widescreen TVs introduced last year, though they were 30" plus monsters.

With the right satellite TV gear, the 8916 can be used to view broadcast movies in all their wide-screen glory. Unfortunately the only service offering that in the UK is via the BSkyB D-MAC Marco Polo satellite, which will cease public transmissions at the end of the year. Commercial videos and films broadcast in 'letterbox' mode on conventional 4:3 aspect ratio TV can be expanded to fill the whole screen, though there is a picture quality reduction. As with the Nokia, the viewer has control over the picture position, which can be scrolled up or down as you wish.

Philips' 100Hz flicker-free technology is standard and something called a colour transient improvement (CTI) and contour booster promises better definition of soft outline pictures. You also get Nicam stereo sound and 2x40 watts of music power via a pair of front mounted main speakers and a rear-mounted sub woofer. At least with these widescreen TVs the stereo separation should be a bit better! Philips even supplies two remote controls – one with all the buttons you could ever want and a second with just the essentials.

Philips: Tel.071 222 0833. ■

Review: Ascom CT128

Arthur King plugs in a cordless phone that uses similar Nicam technology to that used by stereo television.

Nicam audio technology borrowed from the TV industry has found its way into the new Ascom CT128 cordless phone system. I say 'system' because the CT128 features multiple hand-sets and a versatile cordless intercom system.

BBC engineers invented Nicam (Near Instantaneous Companded Audio Multiplex) to include high quality stereo sound with TV picture transmissions. Ascom uses Nicam D and although the 'D' stands for data, this is only for two multiplexed digital control channels separate from the audio section, which remains analogue.

The CT128 is not an all-digital CT2-level device, like telepoint, it uses the same radio frequencies conventional or CT1 phones use. Ascom uses Nicam in mono form to enhance audio quality, especially when the hand-set is nearing the fringe of the base station transmitter range. It effectively reduces the signal to noise ratio by up to 12dB, a bit like dbx noise reduction on some tape decks. Ascom claims the CT128's usable range is improved compared with ordinary cordless phones. As audio transmissions are analogue, conversations through a CT128 handset can still be monitored by somebody with a radio frequency scanner. However, a unique number code prevents other CT128s in the vicinity from making calls on your phone line.

The CT128 is normally supplied with a pair of hand-sets and costs £199.95, though it is possible to buy a single hand-set package for about £60 less. Up to eight hand-sets can be used with a single base-station which has its own microphone and speaker so private intercom calls are possible between the base station and any of the uniquely numbered hand-sets. Two hand-set users can talk to each other, though conversations are dogged by simplex transmissions – only one hand-set is allowed to transmit at a time.

Conference calls are also possible, but they are limited to three minutes duration due to British Standards Institute (BSI) regulations.

An attractive feature of the CT128 is that there's no need to press a button if the phone is answered straight from its recharger cradle. A word of caution here; if the phone isn't replaced accurately, with the charge indicator light on, the phone remains off-hook. This happened to my CT128 twice – most frustrating! Ascom says an audible warning backs up the light, but I have to say I didn't notice it.

The much promoted Nicam effect on audio transmission seems good. At the hand-set end, callers sound very clear and there's much less of the buzzing and fizzing one expects from a cordless phone. The further you are from the base station, the more you are aware of an increasing background hiss, but the phone remains usable at quite long ranges and the expected deterioration in sound quality is gradual rather than sudden.

Unfortunately the story isn't so good at the caller's end. I have now come to expect comments from callers like "are you speaking out of a tin?" or "what's wrong with your phone?". Apparently I sound clear, but strangely boxed in. The boxy sound quality is due to the CT128's hand-set microphone, according Ascom's market development manager, Richard Parsons. He explains that as the phone isn't conventionally 'banana' shaped, the microphone is further from your mouth. The mike's amplifier gain must therefore be set higher than normal and this picks up room reverberations more acutely than ordinary phones. It makes sense but I've had the same comments outside in the open too. Parsons says there are no plans to modify the mike.

The CT128's specifications are very attractive indeed, but I feel it needs more development before I'd buy one. Having two cordless handsets – one for upstairs and one downstairs, for example, makes a lot of sense, and I like the cradle on/off feature.

Summary

For: Versatility, LCD status display, Nicam D transmission, multi-handset convenience, range.

Against: Poor hand-set microphone, dodgy on/off hook cradle switch, annoying simplex intercom, affordability.

Contact

Ascom Telecommunications Ltd, Tel.0222 777 800. ■

Summer CES Part II

In the second half of Ian Burley's report from Chicago he looks at Sony's new camcorder and CD Walkman, AT&T's colour videophone and much more.

Here's our second report on the 1992 Consumer Electronics Show (CES) which took place recently in Chicago.

Sony had a rush of new products to show during CES but, like several other big industry names, chose not exhibit them on the actual show floor. Instead Sony chose CES week to officially open its smart new down-town Chicago showroom. There we were treated to what must be close to the ultimate Hi8 video palmcorder, an enhanced Data Discman electronic book unit, an up-market wireless infra-red HiFi system, an anti-skip CD-walkman and more.

First to the new palmcorder. The CCD-TR101 is an 8mm palmcorder with hi-band or Super-VHS level picture quality. This specification alone was pioneered by Sony only a year earlier but now they have added an image stabilisation system to counter the all-too familiar problem of camera shake typical of such small video cameras.

The latest version of the Data Discman.

Sony's high spec palmcorder.

Rival Panasonic has incorporated an electronic image stabilisation (EIS) system in its up-market palmcorders for a couple of years now but it has been criticised because the technique slightly degrades the picture signal. Instead, jointly with Canon, Sony has devised an electromechanical system which compensates for electronically sensed vertical and horizontal camera movements by actively controlling a small prism situated between the lens and the image sensing CCD (charge coupled device) chip.

Sony says its image stabiliser is superior to rival electronic versions when it matters – as the lens zooms out to a long focal length. It's also emphasised that, because no optical sensing is required, it works much better under low light conditions.

The TR101 sports a 10x zoom with internal focusing and 10-bit digital image signal processing. A 1/3 inch 410,000 pixel CCD chip is used and a digital fader lets you fade a scene out to black or white plus there is a mosaic fade option too. If that's not enough, there's a stereo zoom microphone and a Data Code feature which constantly records time and date information on the tape. The US price is *$1,800*, roughly £1,000 and it's shipping there already.

At the CeBIT Hanover Fair in Germany earlier this year (PE June 92) I spotted a Sanyo version of the Sony Data Discman electronic book which added audio replay to the original's text and graphics capabilities. Sony has now caught up with Sanyo by introducing the DD-10EXB which now supersedes the older DD-1EX. Buyers are tempted by a free bundle of three 'books' – the Grolier Electronic Encyclopædia, Passports World Travel Translator and a non-fiction 'audio book' called Sliver by Ira Levin. The DD-10EXB is listed at $550 (£305).

Other Sony temptations included a CD Walkman which uses the same anti-skip chip-memory buffer system developed for the new MiniDisc player plus a futuristic and very stylish high sensitivity infra-red cordless HiFi stereo speaker system.

Sony was just one of many tele-

Skip proof CD Walkman

vision manufacturers to introduce a VCR+ (Video Plus in the UK) compatible range of video recorders at CES. Video Plus is the new system for setting your video for timed recording by simply punching in a number listed next to the programme in television listing guides. So far this is only available in the UK via a special infra-red remote control which 'learns' your particular video's infra red start/stop/record remote control signalling. In the US, Toshiba was one of the first to introduce a video machine equipped with Video Plus internally – last January at Winter CES – but this has been followed by a rush of models at CES Summer from Fisher, Sanyo, Thomson RCA, Sharp, Zenith and Sony.

One notable absence from the Video Plus fervour is Panasonic, which struggles on gamely with its now out-dated bar code programming system. Philips too has yet to joint the bandwagon. Gemstar Corporation, which invented and licenses Video Plus to third party manufacturers, had some predictable market research results to back up the success of its system. 73% of video owners could not program their videos reliably before Video Plus arrived. 93% of Video Plus owners said they were very satisfied with their units, while a Chester Tyszka from Pittsburgh was quoted as saying Video Plus was the "best thing to happen in the 20th century,"which says a lot about some aspects of American society!

Franklin Electronic Publishers Inc. is usually worth checking out at CES shows. This year Franklin's highlight was a combined speaking electronic dictionary, thesaurus and spelling checker. The Language Master 6000 SE is claimed to be the world's first such device and is primarily aimed at people who have speech, sight or learning disabilities. The pocket-sized device is crammed full of 300,000 thesaurus dictionary definitions with 500,000 synonyms. The spelling dictionary covers 110,000 words and there is an electronic grammar aid too. Words are spoken out loud and pronounced accurately (albeit with a US accent) as well as displayed on an LCD screen. The Speech rate can be changed to match those who effectively have 'speed hearing'. People unable to speak at all can let their Language Master 6000SE unit be their voice instead. The whole unit weighs just 11 ounces, measures 5.5in by 5in by 1in and has a recommended price of $500 (£277).

Sony's entry into the Video Plus market.

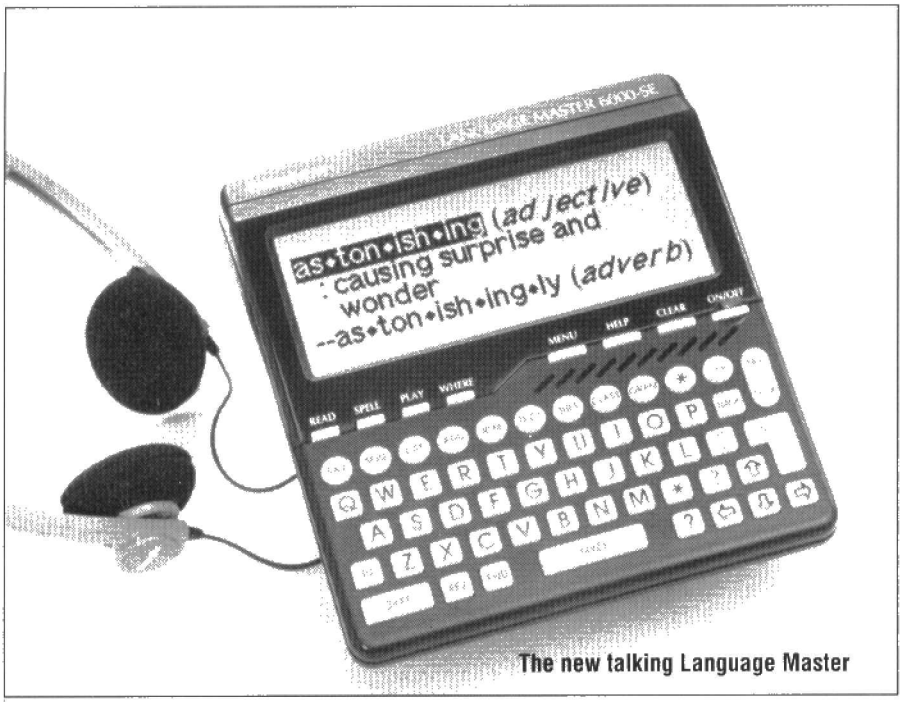
Colour Videophone

AT&T attracted much attention with its colour Videophone 2500. This $1500 (£830) device sports a flip-up colour LCD screen and can be used via a single conventional

Videophone in colour.

phone line unlike other videophones which are designed for special ISDN digital phone lines. Inside the 2500 is a 19.2K bits per second a modem, a video codec (coder/decoder) and an audio processor. 11.2kbps is used for the video portion of the link and the sound channel uses up 6.8kbps, leaving 1.2kbps for future expansion.

Unfortunately the samples I saw at CES had a decidedly grotty picture quality via the 112 by 128 line 3.3 in colour LCD display – on average a decent TV will display at least 400 lines of resolution. The picture was very fuzzy and at ten frames per second, quite jerky too. Nevertheless, it's quite an achieve-



The new talking Language Master

ment to squeeze a colour video signal as well as audio down an ordinary phone line. It will be interesting to see how Amstrad's similar colour videophone compares when it's unveiled, probably by the end of the year.

Also from AT&T is the ultimate office phone with a versatile touch-sensitive LCD display. The AT&T Smart Phone 2100 has a 4x6in monochrome touch-sensitive screen which features 'soft' buttons for functions like memory dialling, phone book entry and editing, speakerphone and ringer volume control, etc. The display is also designed for use with compatible information and management services. For a $100 (£55) installation charge and a monthly fee of around $25 customers of the Huntington Bank based in Columbus, Ohio, can use their SmartPhones to pay bills, transfer money, show account balances and also shop from catalogues. The screen and its soft buttons automatically re-configures itself according to the service being accessed. This sounds remarkably like the Keyline Teleshopping terminal developed here in the UK (PE June 90 and July 92).

Away from the glare of its Newton PDA publicity (PE last month), Apple made a bit of minor history by exhibiting at its first CES show. Besides a five minute promo video in one corner, Newton wasn't featured on the stand itself. Instead Apple was pushing its Macintosh multimedia products very hard. This was the place to be for HyperCard and QuickTime demonstrations. Apple announced a deal to distribute Macs in the US via a big consumer electronics chain store network called Silo, a bit like Dixons in the UK. There were also plenty of new multimedia CDROM 'book' releases and interactive movies from established names like Discis, Broderbund, Icom Simulations and Voyager. Psygnosis also announced the hit Lemmings game would soon be available on the Mac.

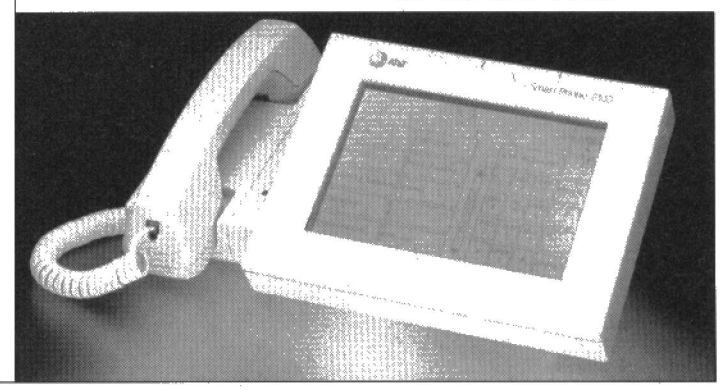
On The Game

The video game war is hotting up in the US, and it's no more evident than at CES. NEC has already had to regroup its video game division after superior 16-bit hardware technology featuring CD ROM options failed to translate into solid sales. Undaunted, a new NEC subsidiary, Turbo Technologies, has been formed to continue the development and marketing of its PC Engine and TurboGrafx game systems. One result has been the TurboDuo, a slimline 16-bit console based on the TurboGrafx system and incorporating a CD ROM player. TurboDuo is the industry's first game console to take both game cartridges and CD ROMs as standard.

Nintendo still has the 8-bit console and pocket GameBoy markets wrapped up, but was a little late into the 16-bit console market. Its Super Famicom or Super NES system is more advanced than the leading 16-bit Sega Genesis (called MegaDrive in the UK) system, but Sega has fiercely defended its 16-bit territory with aggressive price cutting. A Genesis console can be bought for $99 now. In response SNES dropped to $149 but recently Nintendo decided to match the sub-$100 Sega price. It's worth remembering that both started out at $200 (£110) originally and both cost UK customers more in pounds sterling than they do in US dollars! Sega has another ace up its sleeve in the form of a joint venture with JVC to produce a TurboDuo look alike – in other words, a Genesis console with a CD ROM built in. That should sell for less than $300. Incidentally, Sega in the US employs just 230 people yet its turnover is $500 million a year – a ratio of more than $2 million worth of business per employee! ■


Turboduo.

The AT&T Smart Phone



Duelling Cameras: The Compact vs SLR

Modern cameras are getting more and more packed with sophisticated electronics. Carolyn Vaughn takes a look at what is on offer and what good it can do.

Choosing a camera isn't as easy as it used to be. It is not a simple case of choosing a compact, point and shoot camera or a more sophisticated 35mm SLR (Single Lens Reflex). Camera manufacturers are now trying to pack as many electronic features possible onto both types. It has become a competition to create a camera that is more automatic than all the others.

The functions on today's automatic cameras surpass any of the former compacts or SLRs. There are now many choices and functions for focusing, flash, metering, exposure and more. Buying a camera is no longer a choice based on cost and quality, but by the electronic features desired in a camera.

The Compact

A typical compact camera has a 50mm fixed lens with a flash and an automatic metering and focusing system. Its nickname, the point and shoot camera, sums it up well. These cameras are a favourable choice for most people because they are simple to use and usually produce a decent photograph. They are small and easy to carry and all use 35mm film – the highest quality small format film available.

With the technology available, compacts are becoming just as electronically advanced as many of the more expensive automatic SLRs. They are no longer limited to a fixed lens with an automatic flash. The latest designs offer most of the advanced features available on SLR cameras such as, weighted metering, red-eye reduction flash, up-to four focusing modes, self-timer and auto focus illuminator. Nikon's most advanced compact, the TW zoom 105, and Canon's Mega Zoom 105 both have all of these features and both have zoom lens from 24mm-105mm.

Both cameras also have LCD panels like the latest SLR cameras. The LCD panel is on the top or back of the camera. The panels display all of the functions available on the camera such as; the number of exposures, aperture and speed settings, multiple exposures, and even the ASA setting. This panel shows it all. Variations from camera to camera are minimal. On the Nikon TW Zoom 105 the LCD panel is on the back of the camera and below the panel are four small buttons for the photographer to programme in the desired settings. This particular model offers four types of flash.

A pair of autos from Nikon, top the TW Zoom 105, bottom, the AF-801s.

The Terminology

Auto Flash Mode	Flash fires automatically in situations where there is not enough light on subject or overall scene
Autofocus illuminator	Infra-red is used to measure the distance to the subject when autofocusing in low light situation
Aperture priority	Aperture is manually set and shutter speed is automatically selected
Carefree Autofocus	Automatic focus of overall frame, used for most pictures
Continuous exposure	With button pressed camera releases frames continuously at high or low speed
Depth of field preview	With button pressed, previews depth of field of image inside the viewfinder
DX-coding	Automatically reads and sets ASA (ISO) of film
Exposure compensation	Exposure can be set up to ±4 stops, Minolta, and ± 2 stops, Nikon and Canon
Fill flash	Used in situations where subject is dark in front of a bright background. The flash fires a weaker flash to fill-in dark areas to prevent underexposure
Flash cancellation	To shoot without flash in situation when camera would normally fire flash
Focus tracking	Focus continuously adjusts to moving subject
Infinity Focus	Focus is locked on infinity
f-stop	The aperture setting, the smaller the number, the wider the opening and the more light gets to the film but the lower depth of field.
LCD panel	Display panel shows indications for: exposure, metering, exposure/aperture compensation, shutter speed, film speed, DX coding settings, film advance and rewind, battery supply, self-timer, multiple exposure, frame counter
Manual exposure	Both aperture and shutter speed are set manually
Matrix balanced focussing	Focus on overall scene
Matrix metering	Main subject is automatically metered
Self-Timer	After shutter release button is pressed, camera will take one or two frames. Duration time is changeable from 5-30 seconds.
SLR	Single lens reflex camera
Spot Autofocus	Focus on centre of picture frame
Spot metering	Area in the centre of the frame is metered only.
Multiple exposure	More than one exposure on the same frame, up to nine exposures depending on camera
Shutter priority	Shutter speed is manually set and aperture is automatically selected.

Probably the most popular flash mode is the a new red eye reduction mode.

"Red eye" occurs when the centres of subjects eyes appear red in colour pictures. To reduce this, new compact cameras have a red eye reduction mode. What happens is that the camera fires the flash four times instead of one with a weaker flash at a higher f-stop (the aperture setting). The number of flashes causes the subject's pupils to shrink thus reducing the red-eye appearance. The fourth flash is brighter and the shutter releases and takes the photograph.

Some advanced compact cameras also have exposure compensation, a feature normally only available on SLRs. This allows the photographer to set the exposure for up to two f/stops over or under the meter reading in the camera. However, unlike the SLR, the meter reading is done automatically in the compact and does not appear in the LCD panel so the photographer won't know what the true reading was in the first place. The new compacts offer a choice in autofocusing such as, spot auto focus, infinity focus, focus tracking, and carefree auto focus. All focusing is done automatically in compacts and cannot be set manually. Although these new focus settings offer more variety, the photographer cannot see the scene through the range finder as is possible in an SLR viewfinder. Additionally, the meter settings are fully automatic and the photographer is limited to guessing how the image will appear.

Although the new compacts offer infinitely more choices than the former simpler models, they can never really compete with the more advanced SLR camera.

A compact should remain as a camera intended for quick, 'point and shoot' images and not try to overload itself with too many electronic features. The high cost of these cameras will deter most buyers, but those who are interested in the latest technology will undoubtedly experiment with them. A photographer who is used to a simple compact camera will be overwhelmed by the new features and will have to invest a great deal of time in reading the instruction manual.

Top view of the AF-801s showing the controls.

The Auto-focus SLR

Auto focus SLRs first appeared on the market in 1987/88 when Canon launched the first of its EOS series, the EOS 650 and Nikon its first 801 model. Their physical appearance was the most obvious change. The style of these new cameras affected the look of all subsequent 35mm cameras. Manufacturers began making cameras out of polycarbonate instead of more traditional materials like brass and aluminium. This change made automatic SLRs lighter, more compact and definitely sleeker looking, but they also became far more delicate than they had ever been. Auto focus SLRs simply cannot sustain the same wear and tear as the older models made from metal.

Unlike manual cameras, automatic SLRs do not have the traditional dials for shutter speeds and ASA. On most designs the photographer must 'dial' in functions or push a 'program' button . To adjust from a single exposure to continuous exposures on a Nikon 801s, the photographer must depress the 'drive' button on the left side and spin the 'command input dial' on the right until the 'CL or CH' appears on the bottom left corner of the panel. From this simple example, it is easy to see that it takes long time for any photographer, amateur or professional, to become skilled at using all of the available features.

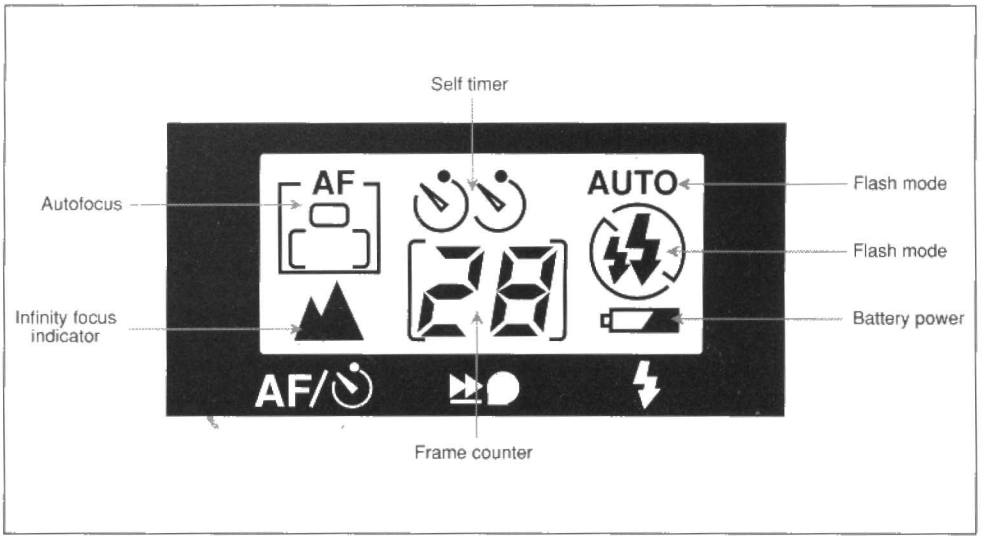
The functions available on automatic SLRs are probably mind boggling to anyone who is used to an old reliable manual SLR such as a Nikon FM2 or a Canon T-90. On these older models, metering a subject meant lining up the needle in the middle of the left of right of the viewfinder to get the correct exposure. To do this the photographer had to adjust either the f-stop or shutter speed, or a combination of the two. On automatic SLRs, if the camera is set in the fully programmed mode, the photographer needs to only aim and shoot. It can be as simple as using a compact camera. When manual functions are desired however, the photographer must programme the SLR to the manual setting. Manual settings are possible for metering, focusing and exposure.

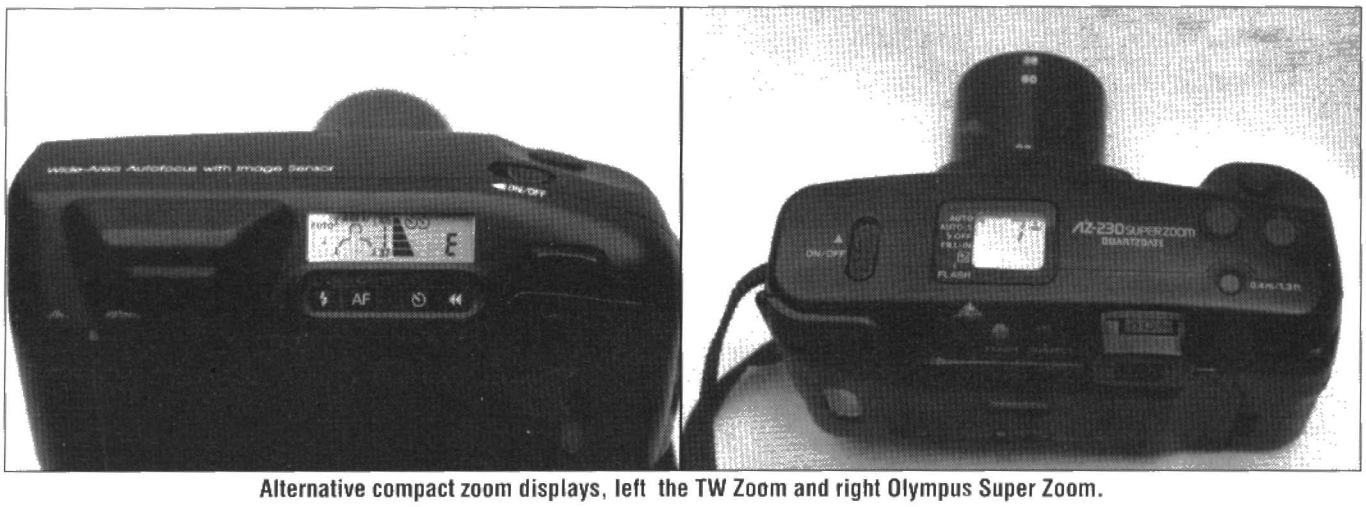
The 801s is Nikon's top camera for amateurs, although many professional use it because it is more modern than Nikon's professional F4 in many ways. For example the 801s has a multiple exposure function of up to nine exposures on a single frame. The 801s and the Nikon F4 have a maximum shutter speed of 1/8000 per second, the highest shutter speed for any camera.

Although camera manufacturers are currently trying to add on all of the latest technology, many photographers still want to have manual capabilities. The Nikon F4 is the top Nikon professional camera, but it offers more manual functions than its amateur counterparts. The F4 still has the traditional ASA button on the left and the shutter speed setting on the right. Even the frame counter is still shown through a tiny glass window on the bottom right-hand corner. It has been updated with a motor drive and there is no longer a film advance lever, but it looks more like a manual camera than an automatic one.

The Canon EOS1000FN and the Minolta 5xi are currently two top amateur cameras. Both of them have many of the same features, including aperture and shutter priority. The photographer chooses to set one function and allows the camera to set the other. Using either of these functions can be time consuming to a photographer unused

Control panel LCD display.





Alternative compact zoom displays, left the TW Zoom and right Olympus Super Zoom.

to the system. Aperture priority can be very useful in situations when a high depth of field is desired. The photographer can set the desired f-stop and allow the camera to automatically set the shutter speed. Both of these cameras have a maximum shutter speed of 1/2000 and a built-in flash system. The 5xi does not have a 'command input dial' like Nikon and Canon, but has two separate program and function buttons. Both flash systems pop-up when needed and both have the red-eye reduction mode.

The development of fully automatic SLR has without a doubt, expanded the capabilities of 35mm cameras. The advanced features offered on SLRs have also filtered down into the compact camera market. Both kinds of cameras perform quickly, quietly, and still allow for many manual functions. However, the demand for manual cameras will also remain constant. Nikon has been manufacturing its FM2 model since 1978. It is the only manual camera Nikon markets and it is one of their best sellers. Canon on the other hand, stopped production last year on its very popular T-90 model, and yet the T-90 remains Canon's most popular manual camera, except that it has moved into the second-hand market. ■

The old reliable Nikon FM-2 manual SLR.

How it works ... Automatic Camera

Minute screws and flexible circuit boards can't stand in the way of Derek Gooding as he takes apart a modern SLR camera to see what is inside.

Good quality photography depends upon the skill of the photographer and the use of the best camera available.

Science plays a major part in the reproduction of quality images. Specialist chemicals are used to form the photo-sensitive multi-layer coatings of either negative films or transparent 'slide' film for positive images. Optical science can manufacture fantastic quality lens elements and mechanical developments combine with electronic control systems producing 'drive' and sensing functions that make life so much easier. It really is amazing just how many poor quality photographic prints are still being accepted as normal.

Modern cameras are complex devices, the higher the price, the better the picture, but only if the camera is properly understood. Knowledgeable photographers know how to avoid the camera's limitations when light levels, background, reflections of flash and so on, create difficulties. For the rest of us it is better to get to know what the camera can do in certain situations rather than miss that 'perfect' shot by not knowing how to set the camera up for it – a little practice and experimentation go a long way to creating good photographs.

Way Back When

In the early days of photography, producing a sharp, clear, picture was mainly dependent upon the quality of the lens plus a massive amount of light outdoors, or the use of flash powder indoors. Individual black and white only glass negatives where another problem. Like many low cost cameras today, fixed focus lenses limited the owner's creativity – getting too closed ruined the focus. To get around this, the focusable lens and eventually the single lens reflex (SLR) camera were developed. Unfortunately, this made things more complicated as lenses that could be focused at any distance are harder to deal with as are the different shutter and film speeds that became available. Automatic cameras are an attempt to get around as many of these problems as possible and most will now produce very reasonable pictures.

Early versions of automatic focusing systems used a range finding mirror system to bring together two views of the picture from slightly different angles. The angles of the mirrors were changed until the two images overlapped precisely – sensed by the light intensity reaching a maximum. Today, infrared light is pulsed through a focus lens towards the object and a timing circuit notes the return pulses. The measurement of the time between transmission and reception gives the distance. A motor driven focus mechanism then sets up a perfect image. Even film loading is now a simple matter with autoloaders and DX film which automatically tells the camera its speed setting. Even lens covers can be motor driven so that they get out of the way whenever necessary but protect the lens at all other times.

Liquid crystal displays inform the user of low light levels, subject to close, low battery, flash ready and so on. A microprocessor is used to continuously monitor all of the cameras functions as well as providing readouts and captions on the photographs. All the user has to do is remember to change the 6V lithium battery occasionally and purchase the film.

Besides all of the automatic stuff, the camera is usually capable of a lot more. A thorough examination of the manual and asking in a good camera shop should clear up most problems. It is also a good idea to take notes as to where and when the camera is used and then match these up with the final results.

Remember that automatic usually means the averaging of readings by the electronic circuits. Human eyes are far more subtle. Note what the camera viewfinder is telling you and then move the camera slightly to see if things change. The focus and light sensitivity settings will register with an object in the middle of the picture but to one side of the object may not get the automatic attention it needs.

Some flash circuits decide when they should give off extra light – it is noticeable that a concerts, many flashes go off because the stage is too far away for the subject to be lit but the automatic mechanism still tries.

Cameras are only as good as their handlers but, don't take it all too seriously. Photography is a science to be enjoyed both by the photographer and by those who view the results. ■

Konica Z-up 80

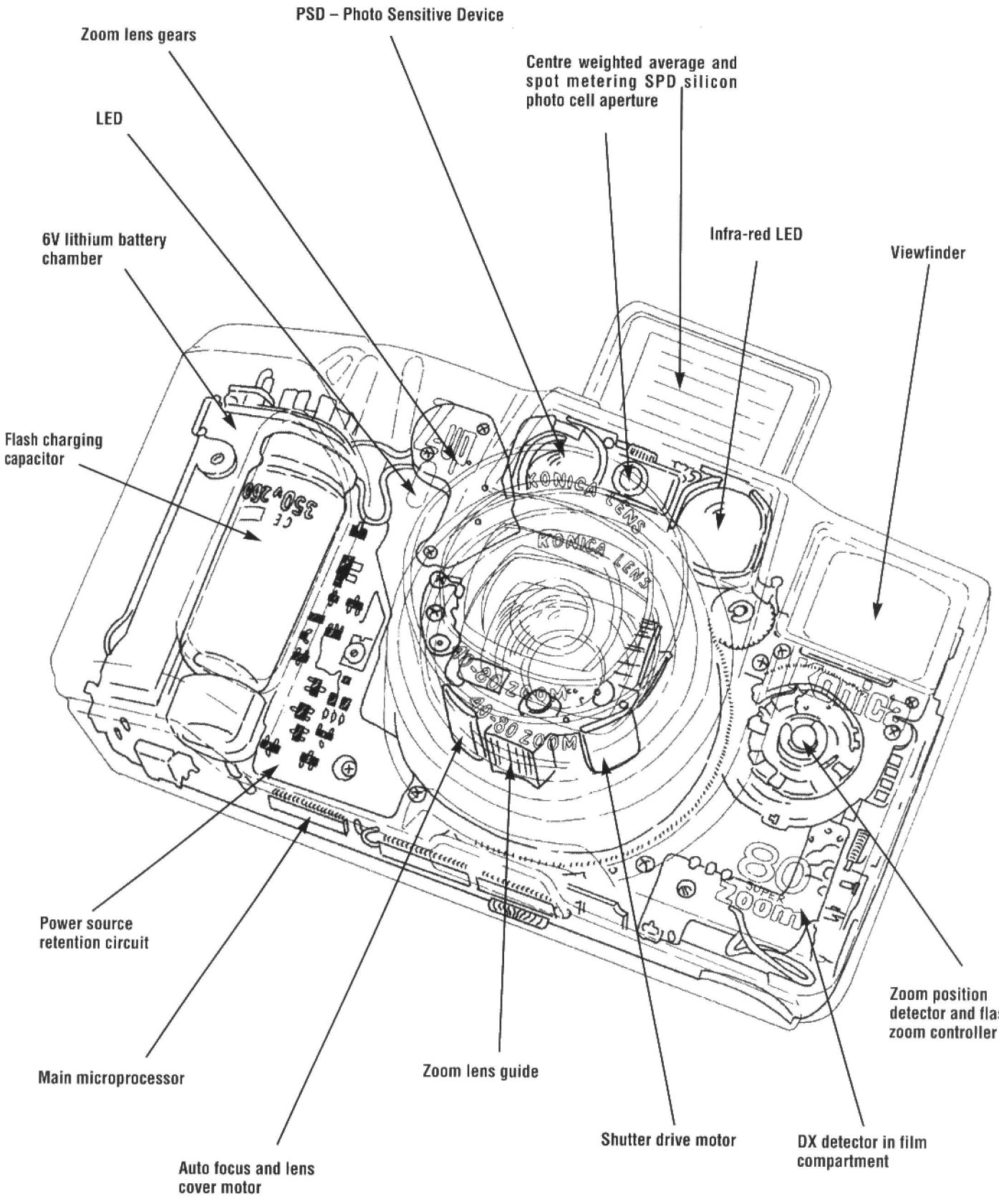


Illustration by Derek Gooding with the kind assistance of J.S. Photovideo (Repairs & Sales), Hanwell, London, W7.

Seeing Visions Of Far Off Lands

Garry Smith and Keith Hamer explain the ins and outs of receiving world-wide TV without satellite dishes.

Nowadays the reception of overseas TV programmes is taken for granted thanks to the widespread popularity of satellite television. However, it could come as a surprise to learn that foreign TV signals have been raining down on the United Kingdom for more than forty years.

Before the advent of satellite broadcasting, the UK viewer was limited to BBC and ITV programmes supplied by their local transmitter, sometimes supplemented by a neighbouring ITV region in locations where the service areas overlapped.

On the Continent, viewers have regularly tuned into programmes from neighbouring countries, especially those living close to the border. Here in the UK, particularly along the south coast and also in parts of East Anglia, signals from the Benelux countries are present to some degree on a daily basis. Further inland extremely weak vision signals from Eire, France, Belgium and the Netherlands are available every day.

Long Distance Reception

The realisation that TV signals can travel vast distances has attracted a growing number of people to a special radio-oriented hobby known as DX-TV (DX means long-distance). The hobby is in some ways analogous to short-wave listening where pleasure is derived from identifying a distant source of transmission - the more elusive, the greater the satisfaction.

There is something intriguing about running a TV set on a vacant channel knowing that a picture may materialise from almost anywhere in the world. This is just one of the attractions of the hobby. It is not so much the content of the programmes but the technical achievement in receiving and identifying the origin of the signal.

TV DX-ing dates back to the mid-Thirties when television was first introduced. During the sunspot peak of the late Thirties, television receivers were shipped from UK to America in order to see if the BBC 405-line signals from Alexandra Palace on channel 1 could be received. The experiment was successful. As television grew throughout Europe during the Sixties, more viewers in this country encountered TV DX signals without realising it. It was the dreaded Continental Interference which blasted Dr Who, and more seriously, Wimbledon tennis from TV screens during the summer. The disruption caused by a phenomenon known as Sporadic-E. Unfortunately, instead of foreign pictures appearing, the BBC picture would be reduced to a mass of white sloping lines. There would also probably be buzzing on the sound channel, especially in areas where channel 2 was used, for example in Lancashire and Yorkshire.

Area	Vision Modulation	Sound Modulation	Sound Spacing
UK and Eire	Negative	FM	+6.0MHz
Western Europe	Negative	FM	+5.5MHz
Eastern Europe	Negative	FM	+6.5MHz
France	Positive	AM	+6.5MHz

Fig. 1. Basic TV system differences found within Europe.

Transmission Systems

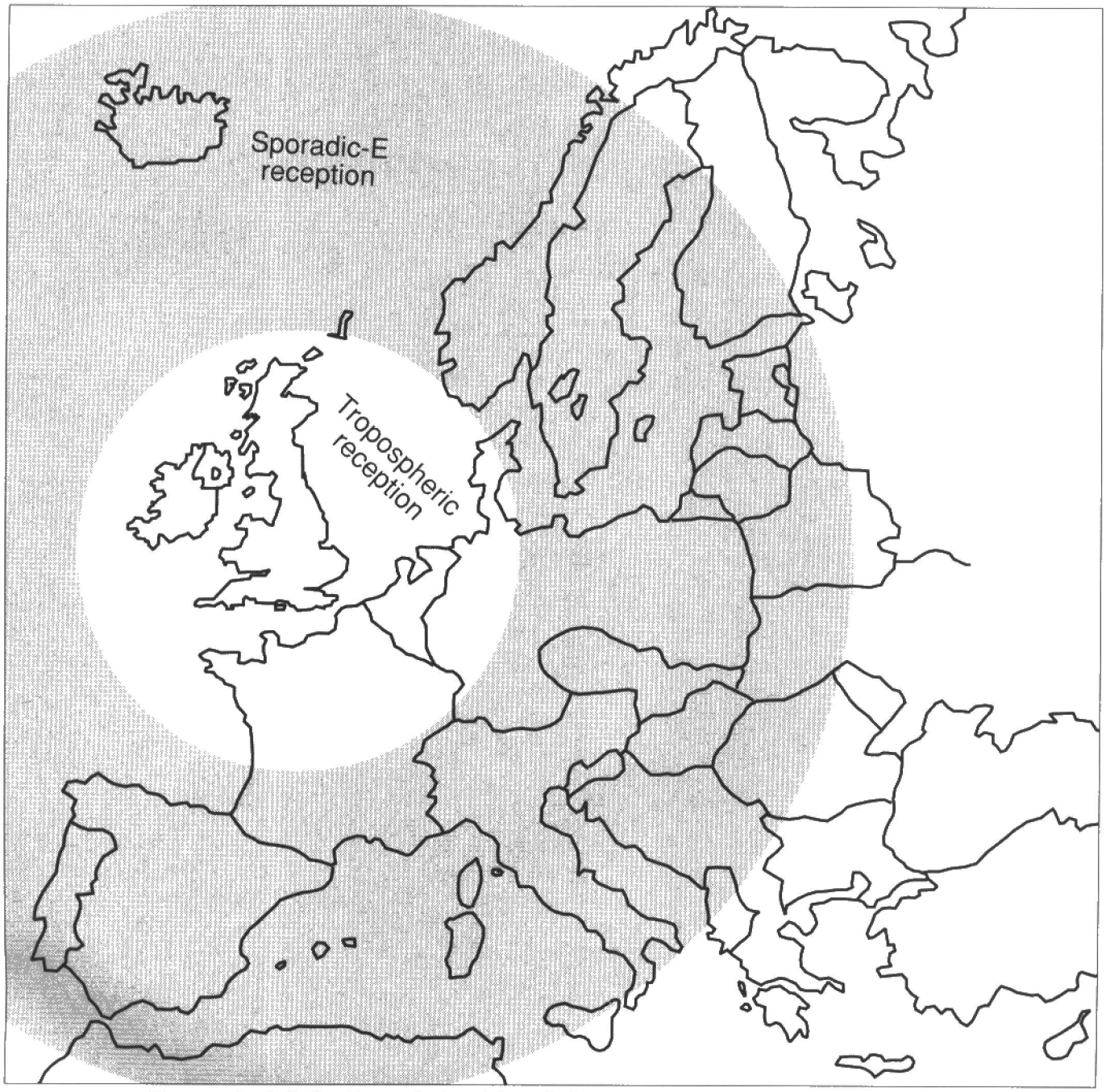
In those days the British VHF channels used 405-lines where stations in Europe used 625-lines (France used 819-line). The incompatibility between systems meant that the viewer could not simply tune into the foreign transmissions.

The incompatibility between the UK system and the ones encountered on the Continent still remains. Nowadays, all European services used 625 lines but with different vision and sound carrier spacings (see Fig. 1) which means that a normal UK receiver will display foreign pictures with sound. French signals pose a much greater problem - not even the picture can be resolved without the help of a special receiver designed for the French system.

It should be noted that overseas broadcasters use VHF channels (Bands 1 and 3) as well as UHF for transmission whereas in the UK only UHF channels are now used. This means that a UK-manufactured receiver will only received UHF.

Propagation

Under normal reception conditions the range of the signal emitted from a high-power transmitter is limited to approximately 100km, although



The approximate limits of tropospheric and Sporadic-E reception at a typical receiving site in the UK..

a sea path can extend this range considerably. Certain atmospheric effects can also increase the range of a result, long-range terrestrial TV reception cannot be reliably predicted in terms of quality and strength. So how so TV signals travel vast distances via atmospheric effects?

Tropospheric Enhancement

Viewers living in fringe reception areas will be only too aware that certain types of weather plays an important part in whether the picture quality will be acceptable or not. High-pressure weather systems have a marked influence on TV signals. These can become trapped within layers about 2km above the Earth thus following its curvature for a hundred kilometres or so before impinging on the receiving site. Signals arriving by this means are relatively stale with few fades.

Periods of reception and last for several days at a time, although there is a tendency for signals to disperse by mid-morning and reappear during the early evening. Reception distances vary between semi-local and 600km.

Sporadic-E Ionisation

Long-range short-wave radio communication is possible due to reflections within the various layers of the Earth's atmosphere, including the E layer; this particular region lies approximately 120 km above the surface of the Earth. Although it is capable of reflecting short-wave signals, television transmissions normally pass straight through it and are subsequently lost forever in outer space. However, during the summer months the E-layer becomes highly ionised. If the electron density is sufficiently high, transmissions on the lower VHF TV channels (and very occasionally the FM radio band) will be reflected or, more accurately, refracted back to Earth.

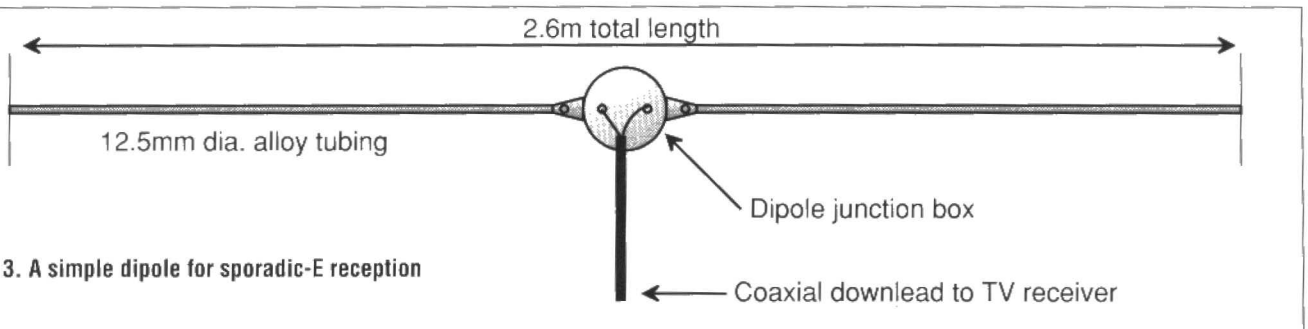


Fig. 3. A simple dipole for sporadic-E reception

Due to the unstable nature of the E-layer, this type of reception is completely random in direction, duration, signal strength and distance. Sporadic-E signals can attain very high field strengths and consequently impressive results can be achieved using simple aerials. Since the signals are refracted within the upper atmosphere by intense ionisation, a skip distance is involved which is typically around 1500km. Occasionally, long range reception is possible from the Middle East, Africa or North America.

F2-Layer Activity

An increase in sunspot activity can also provide long-distance signal paths in excess of 10,000km. F2 activity peaks approximately every 11 years and the present cycle is drawing to an end. Activity is at its highest during winter daylight hours and only the lower Band I TV channels, around 50MHz, are affected. Signals can be strong but pictures are usually marred by severe multiple ghosts which can make precise identification difficult. Despite this, regular identification of countries such as Australia, New Zealand, Thailand, Malaysia, Italy and Dubai has been possible over the past four winters.

Suitable Receivers

A normal UK receiver will provide UHF reception only. At certain times of the year, particularly when co-channel interference announcements are heard, conditions can be favourable to allow transmissions from the Benelux countries and Germany to penetrate into central areas of the United Kingdom. Sometimes a cContinental picture can be seen superimposed in the background of the local BBC or ITV transmission and a check on normally vacant channels, especially on the lower part for the UHF band, may reveal good quality colour pictures from the Continent. The emergence of other ITV regions will also indicate that conditions are favourable.

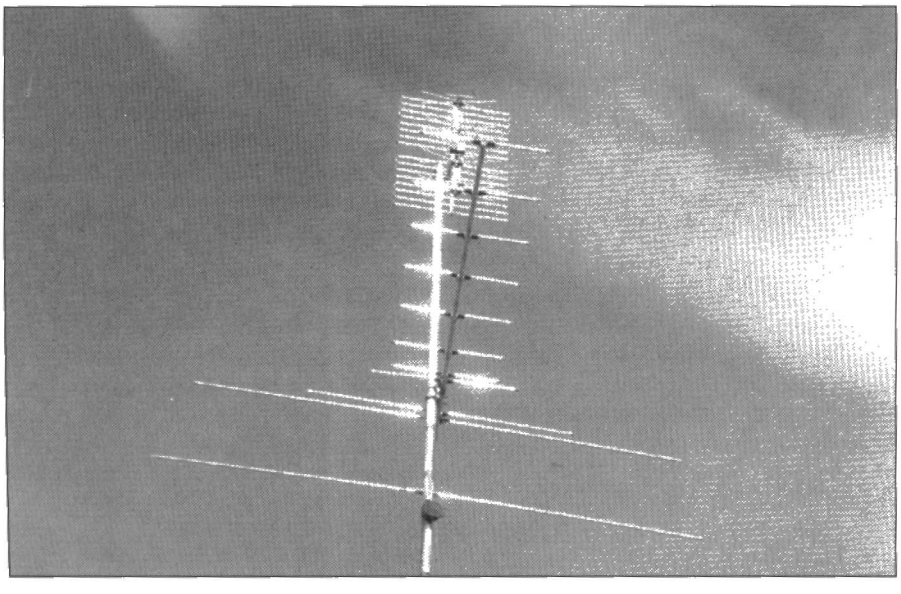
The most interesting reception occurs via Sporadic-BE propagation in Band i and its is this band which enthusiasts find the most intriguing. A multi-band TV or converter is required to cover this band but first check the tuning scale of the TV receiver. Some imported sets are equipped with a multi-band tuner as standard and just a flick of the bandswitch is all that is required to produce a suitable monitor. Such receivers usually have a tuning scale inscribed with VHF channels 2-4 and 5-12, in addition to UHF channels 21-69. It should be noted, however, that this is not a guarantee that a VHF tuner will have been fitted during manufacture.

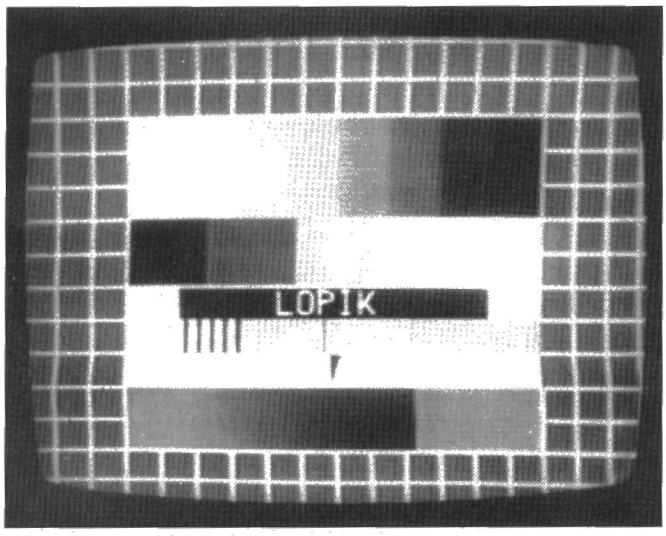
Modifying a receiver by fitting a VHF tuner is into recommended because of the safety aspect – a live chassis is present in most receivers. Also, the manufacturers warranty will be invalidated.

Converters

A special converter system, knows as the D-100, has been available for some years. The unit simply plugs into the aerial socket of a normal TV set; with this approach, no modification are required to the TV receiver. Dial tuning provides full VHF and UHF channel coverage. To overcome sound incompatibility between the UK and overseas systems the sound is separated form the composite TV signal within the converter and then fed to an FM radio tuner to provide high-quality sound of any spacing. The converter also features vision bandwidth reduction which produces a more distinctive image when a weak signal is being received. Some satellite systems are now including this type of feature although picture definition deteriorates when the bandwidth is too narrow. However, this is a minor hiccup when trying to procure a signal from virtually nothing!

An all-channel TV aerial system suitable for every type of propagation.





Tropospheric reception at UHF from Lopik in the Netherlands.

Aerials

For Sporadic-E reception, a simple aerial, known as a dipole, can be used (see Fig 3). Dipoles of this size were commonly sent for receiving BBC-1 transmission on the now defunct 405-line systems on channels 1 to 5 . The dipole should be mounted with the rods horizontal and facing the Continent. It should be note that aerial height is not too important because the signals arrive at an angle. However, it is advisable to achieve to achieve a minimum height of 5 meters to be clear of local obstructions such as next door's pear tree!

It is permissible to mount the dipole in the loft and still receive signals from distance places, but it should always be borne in mind that a well sited indoor aerial is never as good as one badly sited externally.

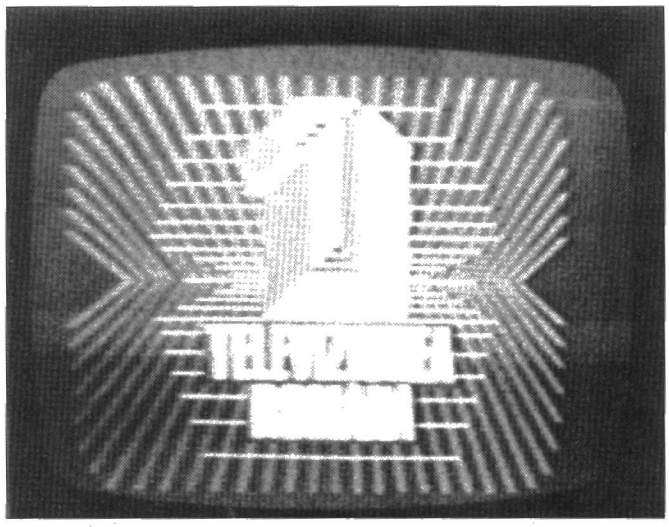
Aerials for tropospheric reception should be mounted as high as possible although chimney height is sufficient in many locations. Some form of rotation is desirable otherwise reception may be limited to one direction only.

An aerial with four elements or more is required for Band III channels; its overall size is much smaller than an FM radio aerial.

For UHF reception a domestic 18-element aerial can be used but because these are usually manufactured for groups of channels, three such aerials would be required to provide full coverage of the UHF spectrum.

Wideband (all-channel) aerials are available featuring a chain of X-shaped elements but be prepared to pay as much as £75 for one depending upon the manufacturer. A compact wideband aerial known as a grid is far cheaper and is aesthetically more acceptable in any location.

Amplifiers are not essential but may be added later a refinement, unless you intend to have a very long down-lead where signal loss will be inevitable. The amplifier can be installed at the mast-head end of the cable to overcome this loss.



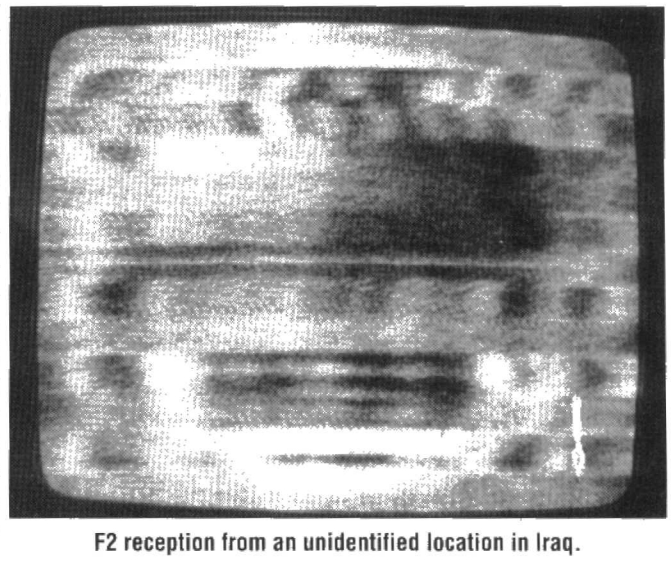
An identification caption from Rumania received via Sporadic-E.

TV broadcasting is changing rapidly. On-screen presentation has become more complex with graphics replacing static captions. Many services now broadcast round-the-clock, dispensing with the traditional test card and station opening sequences, so making identification more difficult. On the other hand, a few eastern European stations are still caught in a time warp with Sixties-style presentation being the norm. Recent political changes in the east are affecting the colour systems traditionally used. This year many Czech and Slovak transmitters are being converted to PAL operation and Hungary is expected to follow.

Encryption is being introduced by terrestrial network and already there are many independent services overseas operating Pay TV channels. The French were the first to launch a terrestrial service nationally. High-definition terrestrial broadcasts may not be far away. It is worth remembering that history may be repeating itself – until the launch of Pay-TV in France, an 819-line system with a video bandwidth of almost twice that of a conventional system was in the use right up until early Eighties.

Where To Find Help

There are technical publications covering every aspect of long-distance TV and some of these may be found in local libraries. The World Radio TV Handbook is an excellent guide listing overseas TV transmitters and transmission systems used. A range of publications, converters and aerials suitable for DX-TV are available from specialist suppliers much as HS Publications, 7 Epping Close, Derby DE3 4HR (Tel:- 0332 38 16 99.) A SAE should be sent with any enquiries. ■



F2 reception from an unidentified location in Iraq.

The Wizardry Of Electronic Imagery

Kenn Garroch explains what can be done with electronic image manipulation – does the camera ever lie?

The idea that photographs never lie has possibly never been true. With the advent of cheap, high quality image scanners, image processing software and 'electronic publishing' or DTP, the ability play around with pictures has never been easier.

Possibly the only point at which the photograph is a true representation of the scene is while the film is still in the camera. The developing and printing process allows modifications to be made to the colour, brightness and size of the image.

In the days before high power desktop computers, prints could be touched up here and there to remove blemishes. However, this was an artistic job and took a good deal of experience and talent – something that is no longer true with electronic systems. Any picture published in a modern book, magazine or newspaper will almost certainly have been electronically modified in some way and many poster advertising campaigns now rely completely on computer technology and software for their very existence.

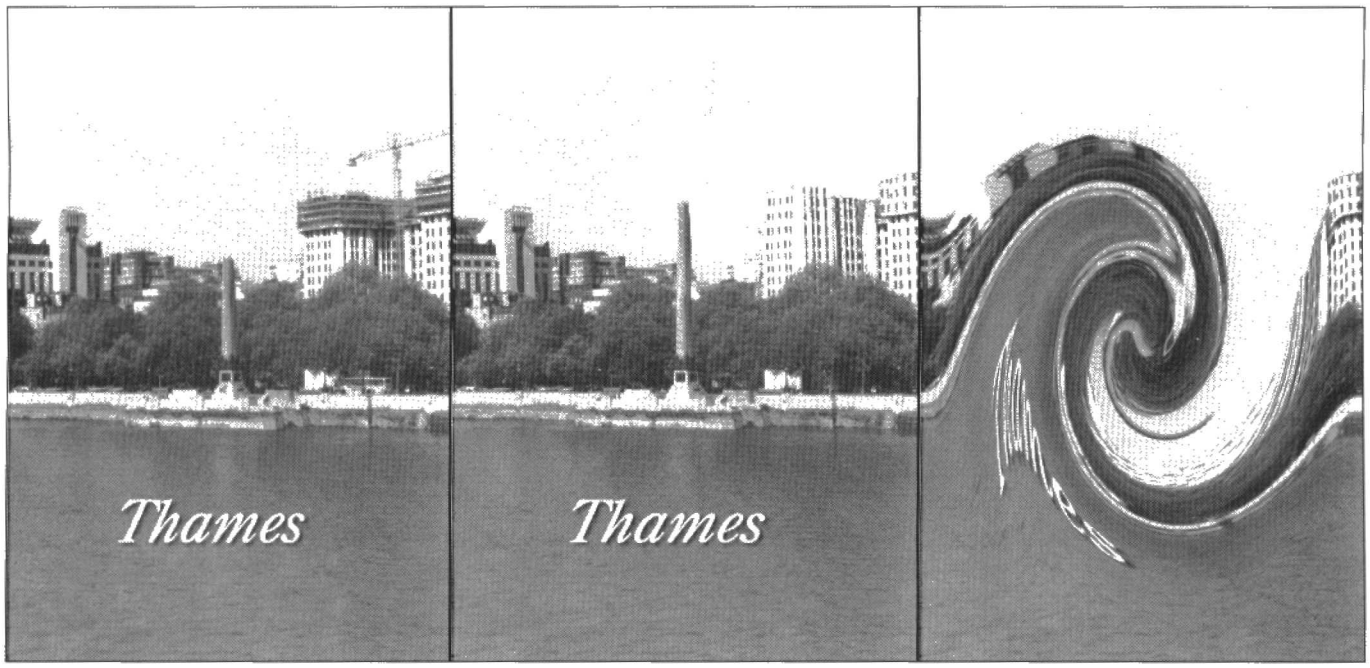
Into The Machine

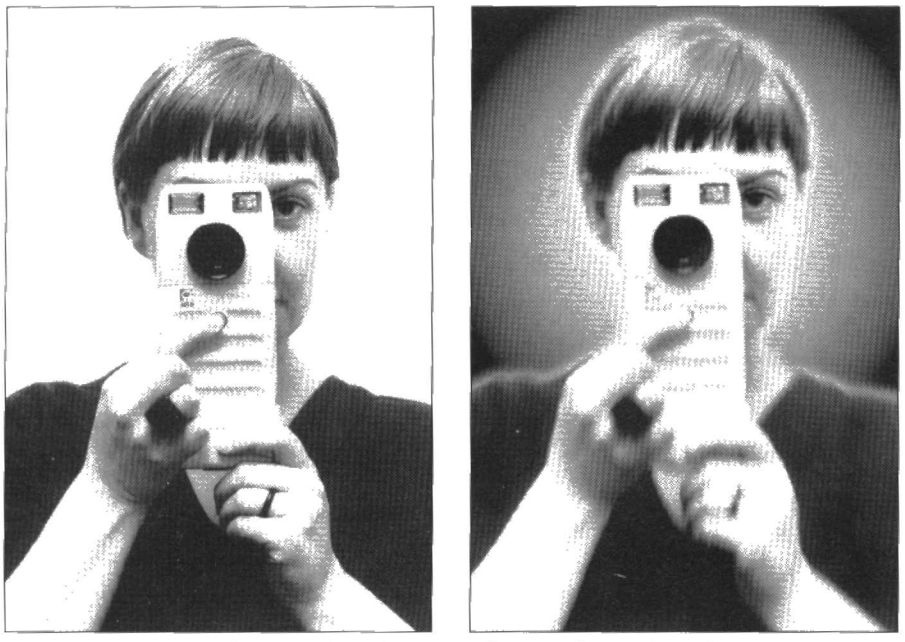
The first step in getting a photograph into a computer is to scan it. This can be done either from a transparency, a negative or, most cheaply, from a print. All of the photographs in PE are scanned on a desktop scanner costing around £2000. In general, the computer manipulation required to get them to the pages is minimal, simply a matter of re-sizing and lightening in most cases.

The most important aspect of a scan is its resolution. Looking closely at the printed pages, the dots which fool the eye into thinking that there are continuous shades of grey in a black and white image are evenly spaced at 120 per inch – a square inch has a total of 14,400 dots in it. Different sizes of dot give the impression of different levels of grey – since the page is white, a full dot gives black and no dot at all gives white. Colour images use a mix of four dots with the colours Cyan, Magenta, Yellow and Black (CMYK) at 133 per inch and, when viewed from a normal distance, fool the eye into seeing perfect colour images.

To get the best result from a black and white or greyscale image, it should, ideally, be scanned at about twice the resolution at which

Image manipulation in Adobe Photoshop.





The original on the left and an edited version on the right.

it will be printed. In practice, nowhere near this resolution is needed and 150 dots per inch (dpi), giving 22,500 dots in a square inch, is usually good enough, even for colour.

The resulting image file is about 21kbytes per square inch for 150dpi greyscale and 65kbytes per square inch for 150dpi colour. Changing the resolutions to the ideals of 240 and 266, these grow to 56kbytes and 207kbytes respectively. Colour images can take up a lot of disk space and care needs to be taken to keep them as small as possible.

Also of importance in a scan is the number of levels of brightness measured. In most instances this is 256 and can be conveniently represented in a computer as an 8-bit value. If less levels were used the image would appear to step from one level to the next without a smooth transition . A colour image works in exactly the same way but is scanned three times through red, green and blue filters. Again, each primary colour is assigned one of 256 brightness levels so the final image is said to be 24-bit colour (three layers of eight bits.) This allows 2^{24} or 16,777,216 colours to be represented, more than enough to fool the eye.

Once in the computer, the scanned image can be displayed on a monitor screen. The quality of the image depends on the capacity of the monitor. 24-bit colour monitors are rather expensive (in the region of £2000) and 8-bit colour as used in SVGA systems can be used to give some idea of the result. Greyscale images can be viewed on greyscale monitors with almost perfect results, the only drawback with all of these methods is that monitor resolution is usually only about 72dpi. Fortunately, all of the image information is retained so that it can be output onto a device with a higher resolution.

Image Formats

There are a number of ways in which a picture can be stored in a computer. During the scanning process, it is split into small squares known as picture elements or pixels. In black and white pictures, each of these is assigned a number which represents its brightness. Normally this would be from 0 to 255 and is known as a greyscale. Colour pictures can be scanned through three filters, red, green and blue (RGB), with each forming its own greyscale. An RGB image therefore takes up three times as much space as a black and white. Another alternative is HSB; hue (colour), saturation (purity of colour) and brightness (the additive primary colour with the highest value) or HSL which is the same but the lightness is the average of the lowest value primary colour with the highest. CMYK splits the RGB into four layers, Cyan, Magenta, Yellow and Black and is commonly used in printing (take a very close look at the cover of the magazine for an example).

Graphics File Formats

Until very recently, computer graphics files came in a wide variety of formats. The incompatibility between them was, and still is, a source of great trouble and a selection of conversion programs is needed to transfer one from the other.

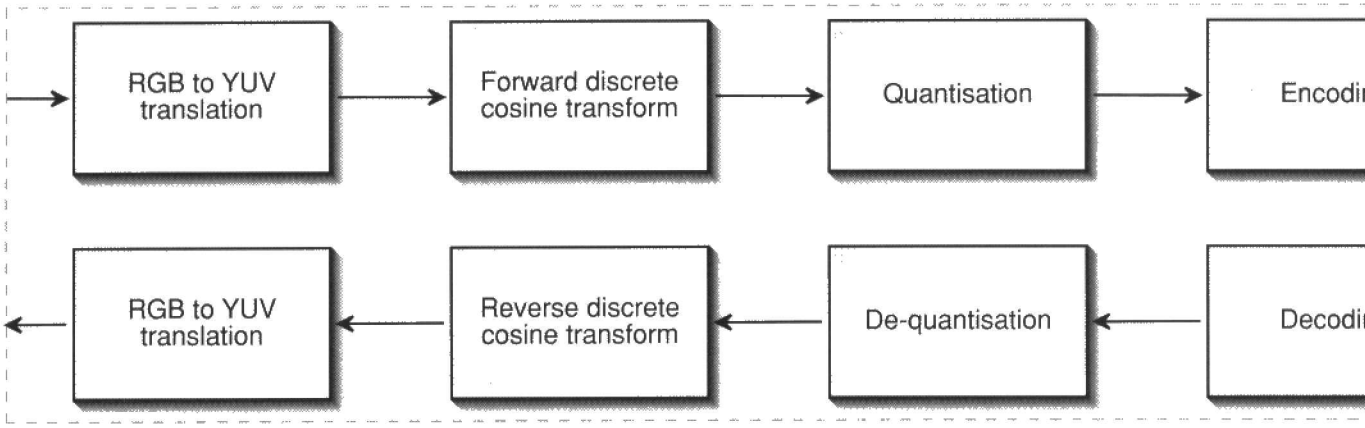
With the increased use of computer imaging and the entry of large software houses onto the scene, some standardisation is starting to enter the market place. The type of file usually depends upon what machine and package it was produced with.

In electronic publishing, or DTP, common file types are TIFF (Tag Image File Format) and EPS (Encapsulated Postscript). Tiffs can be used to store bit images such as scans or screen dumps but are usually only reliable in black and white or greyscale (another term for black and white) – until very recently there was no colour standard available for TIFFs.

EPSs on the other hand, actually contain written descriptions of images. If the drawing came from a graphics package such as Aldus Freehand or Adobe Illustrator, then the EPS describes each box, line, curve and fill. Postscript is actually a computer language especially designed for describing pictures and has the great advantage of being largely device independent – it presents an image at the maximum possible resolution capable from the screen or printer. It also has the advantage of being able to cope with full colour images in a range of formats; RGB, CMYK, HSB and so on.

Other graphics file standards are available. A common one is the PCX which is usually used for screen dumps on IBM PCs. Others include GIF (apparently pronounced jiff in the USA) with its built in compression, PICT, TGA, RIF, ILBM and IFF – the last two being common Amiga formats. Unfortunately, although files might appear to have the same format, standardisation is not yet at the stage where they will be read by all programs and there is still some way to go.

Image Compression In Practice



The Joint Photographic Experts Group (JPEG), a combined committee of the CCITT (International Telegraph and Telephone Consultative Committee) and ISO (International Standards Organisation), was set up to research and define a standard algorithm for compressing images.

The aim of the JPEG compression standard is to reduce continuous tone images – generally this means pictures produced by chemical photographic means rather than digital cameras though it will work for both – of either colour or black and white (greyscale) formats by a ratio of at least 24:1. The actual algorithm has three parts, baseline, extended and special. The first reduces the image size by removing unnecessary data – a lossy technique – and is used in all JPEG transformations. The extended and special systems add features such as better coding, lossles transmission and progressive buildup.

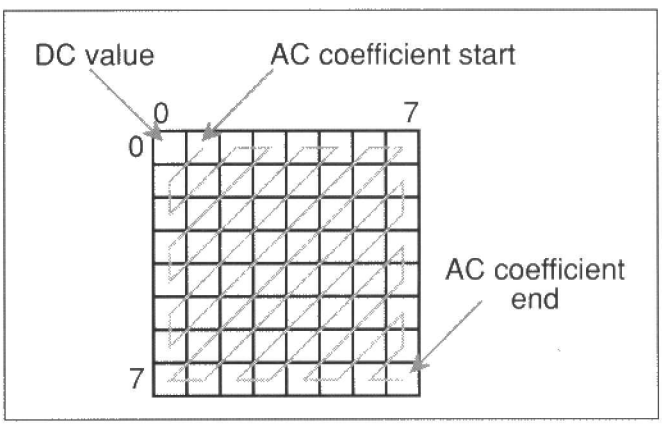
$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.169 & -0.3316 & 0.500 \\ 0.500 & -0.4186 & -0.0813 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Squashing In Action

There are three main stages to the JPEG algorithm, the removal of redundant data by means of the discrete cosine transform (DCT), the quantisation of the DCT coefficients using weighting functions optimised for the human visual system and, finally, coding of the data to minimise the entropy – usually reducing the number of bits in the data with a variable length code.

JPEG is designed to be independent of the colour space and handles colour separately. Normally this means splitting the image into its component red, green and blue (RGB) parts or channels and encoding them separately. The advantage of this is that images created with different colour systems such as CMYK (Cyan, Magenta, Yellow and Black – the process colours using in the printing industry) or HSB (Hue Saturation and Brightness – used in some TV systems) can be compressed using the same technique. Since each channel to be coded is simply a set of brightness values or a greyscale, black and white images can simply be treated as a single channel.

The best compression results are achieved if the colour components are independent (non-related) as in the YUV system where most of the information is concentrated in the luminance. YUV is used in the PAL and NTSC television systems with the Y value representing the brightness or luminance of a picture element (pixel) and U and V, the chrominance or colour, being derived from the blue



and red signals respectively. The matrix operation shown below defines the conversion from RGB to YUV as used in JPEG compression. An additional advantage of this system is that U and V do not need to be displayed as frequently as the brightness because the human eye is much more sensitive to brightness than it is to colour. By removing every other U and V element, an immediate data reduction of 3 to 2 can be achieved.

Transformations

To start the JPEG compression, the image is divided up into blocks of 8x8 pixels which form the input to the discrete cosine transform (DCT). In an 8x8 block the variation in pixel values should not vary too much and can be said to have low spatial frequency. The DCT can be thought of as a Fourier transform that retains only the real or cosine part. This type of transform converts time space data to a frequency space – exactly as is done in a spectrum analyser. The result of this is another 8x8 block with the mean value in the top left hand corner and the higher frequency components progressively distant towards the bottom right – higher row and column numbers represent the corresponding horizontal and vertical frequency coefficients.

The next step is to quantise the frequency coefficients to reduce their magnitude and increase the number whose value is zero. Coding then re-arranges the coefficients into a zig-zag pattern and, because there are a large number of zeroes, a run length encoding technique reduces the data even further. The mean values at the top left hand of each image are coded separately and all the data is then encoded again using the Huffman technique. This reduces the number of bits in the data by assigning short codes to frequently occurring symbols and longer ones to those which are not so common.

When colour images have been encoded, they are stored in an interleaved pattern so that they can be decoded 'on the fly' allowing the image to be built up in a single pass. As an example, a 3.2Mbyte image can be compressed to 155kbytes with no perceptible loss of quality.

Making Some Mods

When stored as a computer file, the image data becomes wide open to manipulation. Probably the most popular package for image manipulation is Adobe Photoshop on the Apple Macintosh. This allows a variety of operations to be made on an image from simple things such as lightening and contrast enhancement, to complex processing such as swirling and even pointilising. Sections of picture can be copied, stretched, rotated, coloured, blurred, sharpened and removed. The whole picture can be resized, have its resolution changed and be mixed with other pictures – the possibilities are almost endless. The only problem is the time it takes to perform an operation and the amount of disk space required to store working files. An A4 colour image scanned at 150dpi needs at least 12Mbytes total space to work on and, depending upon the power of the microprocessor, can take five or ten minutes over some manipulations.

Saving Space

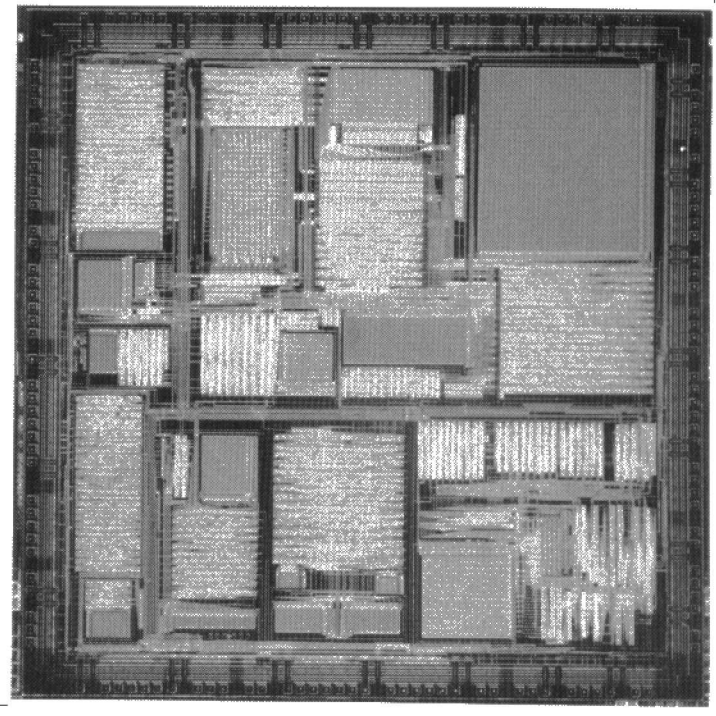
One way to save on the storage space needed for colour images is to compress them. An international standard now exists for this known as JPEG (it was defined by the Joint Photographics Experts Group) and aims to reduce a picture size by about 24 times – with no perceptible loss of quality (see box). The image processing company C-Cube has recently announced a chip, the CL550 processor, which is able to perform the compression and decompression has a throughput of up to 2Mbyte per second. This will allow images to be stored on conventional computer hard disks in compressed form and retrieved and expanded for use with almost no additional delay. In the end, however, the only real solution to the storage problem is to use high capacity systems such as optical disks.

Believing What You See

With all of the developments that have taken place over the last few years in computerised image processing, the appearance of such science fiction type gadgets as video phones, electronic cameras, and hard copy print-outs of TV pictures has become reality. The problem that has yet to be faced is to what extent should images be manipulated. A photograph can no longer be said to show the truth. Will standards have to be set? Is there any way to enforce them? Perhaps the only real solution is for people to know what is possible so that they don't have to believe what they see with their own eyes, all of the time. ■

Full Motion Video Compression

Not content with image compression for stills, C-Cube has also produced a chip (the CL-450, shown right) which can decode moving images of 320x240 pixels at 30Hz or 352x288 pixels at 25Hz. This allows it to be used with systems such as CD-I to achieve full motion video and play back the 70 minutes or so of video that can be compressed to fit



High Culture In The Great Outdoors

Fiona Gammie and Carolyn Vaughn pack up their opera glasses and picnic hampers to investigate the technical nightmare of staging an outdoor theatre production.

Outdoor entertainment in the UK may sound a technological nightmare to those familiar with our somewhat changeable weather. Talk to the director or artistes and they will cite distractions as the major problem. Talk to the technical crew and their catalogue of potential disasters will run from freak tornadoes and power cuts to birds nesting in the lighting rigs. One is the symptom of the other: if the stage is under the flight path to Heathrow you can hardly expect the audience to hear let alone follow the intricacies of Shakespearean dialogue.

The Royal Borough of Kensington and Chelsea's Holland Park Theatre eliminates some of the major elemental problems with a huge high tensile canopy over the stage and audience designed and built by Soft Shells Ltd. It was installed five years ago and it has been worth it. "Since we have had the canopy we have never had to cancel," said Bernadette Cochrane, the production manager.

Not so in the Open Air Theatre in Regent's Park, which 60 years on, still battles with the elements in its beautiful leafy amphitheatre. Both theatres have proper seating stands for the audience and, in terms of theatrical content and technical direction, are just like conventional theatres with no walls, and in the case of the Open Air Theatre no roof.

A month before the opening night of the season in Holland Park Theatre the huge PVC canopy is installed and over the next three and a half days it is washed, tensioned and re-tensioned. With a one and a quarter tonne weight loading, this is as important to a successful season as the actors' learning their lines.

Next, the stage is built and the electrics are installed. This is no simple task: in the Open Air Theatre a mere 10km and in Holland Park over 17 miles of multi-core cable are installed. In the latter, the wiring and design is contracted out to a company

called Stage Electrics. They start with a 200 amp and a 100 amp supply at two different junctions on the site and finish with a full set of "house" lights and enough lanterns to satisfy the lighting director.

The two power supplies compliment each other with the main stage and house lights running off the 200 amp and the emergency and side lighting from the other. Despite their location, all health and safety regulations have to be adhered to and this includes getting the audience safely out of the theatre if necessary. The dual supply ensures these can be met bar a total power failure in West London.

The stage is lit from an arrangement of lanterns and power cans in a hexagonal arrangement supported by a hefty truss. There is some additional back lighting but as the stage backs onto Holland House, a grade one listed building, it is limited because nothing can be attached to it. All of this stage lighting is run from the 200amp supply.

In the Open Air Theatre the set-up does not have the same restrictions and stage lighting is provided in the main by free standing pylons around the arena. There are also more conventional footlights and spots around the actual stage and suspended from the trees and set.

In a conventional theatre the wiring will be contained in the building structure. In the Holland Park Theatre the canopy ceiling holds its weight capacity without additional wiring, there are no walls and so the only option is to go underground. This may be an atheistic solution but when it comes to locating and fixing loose wiring, and remember there is 17 miles of it, it is not ideal. It is with obvious relief that Anya Tapping, the chief electrician explains how, this year, Stage Electrics made locating faults a lot easier. "There are no breaks underground and so all connections are under pit covers," she explains.

Electrics and water do not mix but, as Luciano Pavarotti will tell you, stage any big production outside on a British summer evening and like it or not, your electrics could get wet. The theatre or opera-goers at Holland

Park are basically protected by the canopy – save the run from taxi to theatre entrance. A bit more care has to be taken with the light fittings, dangling so beautifully off the trees, and the junction boxes. These all have to be waterproof.

"We have had two horrendous downpours," said Anya, "and only lost one exit lamp."

The Open Air Theatre in Regernt's Park is more susceptible to the weather and productions have to be cancelled in very bad weather. Nevertheless, they have a stoic "It'll be alright on the night" policy with no shows being cancelled before the advertised start time

Damp appears to be more of a problem. The stage lanterns are all enclosed explains Bernadette Cochrane but the power cans, a larger type of light, can blow if it there is a lot of water vapour in the air.

The twelve week season involves fourteen different productions including opera, dance and theatre at Holland Park. Along with each show comes its own set and lighting designer. In a conventional theatre the lanterns are focused and coloured to produce the desired effect. The same is true in the Holland Park Theatre but the designer has to work hard with the lighting rig to produce the same effects without changing the delicate weight loading.

The main problem appears to be too much light. Even as the evenings draw in towards the end of the season, there is too much light to try any spectacular effects before the interval. Producers and designers are made aware of this when putting forward production proposals for the coming season. Shakespeare is a favourite after all he never wrote with a centrally heated homogeneously lighted auditorium in mind.

Adjustments are made from a mini mobile crane known affectionately by the stage crew as the "cherry picker". Indeed it looks as if it has been borrowed from the park keepers and is driven into the pit during the fit-up.

During the production all the lights are run off a standard Gemini lighting board on the control desk at the back of the stand. Lighting cues are programmed into the computer during pre-show focusing and run through the 90 channels as the production evolves. House lighting and security lights around the theatre are controlled from a separate manual board on the control desk.

High winds can be a problem and watching the rig gently swaying in the breeze can be a little worrying for Bernadette Cochrane, production manager at Holland Park Theatre. She watches the weather forecast for gale warnings but says each worried phone call to their fitters has been met with cheerful reassurance. "Nothing short of the hurricane a few winters ago would bring it down," she says.

Of more concern is the sway produced on the actual light beam. Apparently there is only one solution to this which involves a little co-operation from the performers, who become adept at swaying in time to the rig and not necessarily the music.

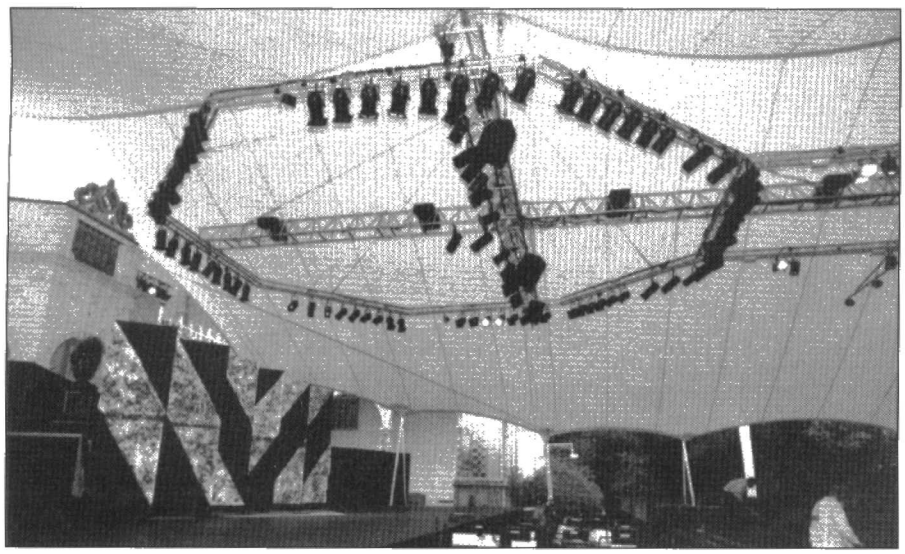
Wind also carries away voices and so effective relaying of sound to the whole audience cannot be left to the strength of the performers' vocal chords. In Holland Park Theatre a sound reinforcement system is used rather than the more standard amplification rig. In practical terms this means different types of microphones and electrics are used to keep within the 80 decibel limit, agreed out of courtesy to local residents.

Of course nothing can be done about the occasional helicopter or nesting pigeon but that tends to be left to the discretion of those on stage. Some would argue that these outdoor sounds are infinitely more preferable than the rustling of chocolate wrappers or snores of the elderly gentleman three rows in front. (It is virtually impossible to fall asleep in an outdoor theatre as it is just too cold!)

Audiences complained of a definite drop off in levels around the middle of the seating stand. This has been solved by a delay line across the back of the stand. It has also been encircled with an induction loop to improve the quality for members of the audience wearing a hearing aid.

This summer a Videolink was installed front of house and at the box office so that latecomers can keep up with the performance until they can find their seats at a suitable juncture in proceedings. Several conventional theatres could be well advised to follow suit.

In short Bernadette Cochrane sums up, "There is very little that we have got here that you don't have in a conventional theatre. Things may be done in a different way but the principal is the same." ■



New Technology Update

Ian Poole reports on techniques for cooling integrated circuits, higher density gate arrays and microscopic electric motors..

Gate arrays are standard building block integrated circuits which are built up to give the correct functions by different interconnections between the on-chip gates. However, it soon arises that is impossible to connect all the gates because today's chips generally use two layers of metallisation for the interconnections.

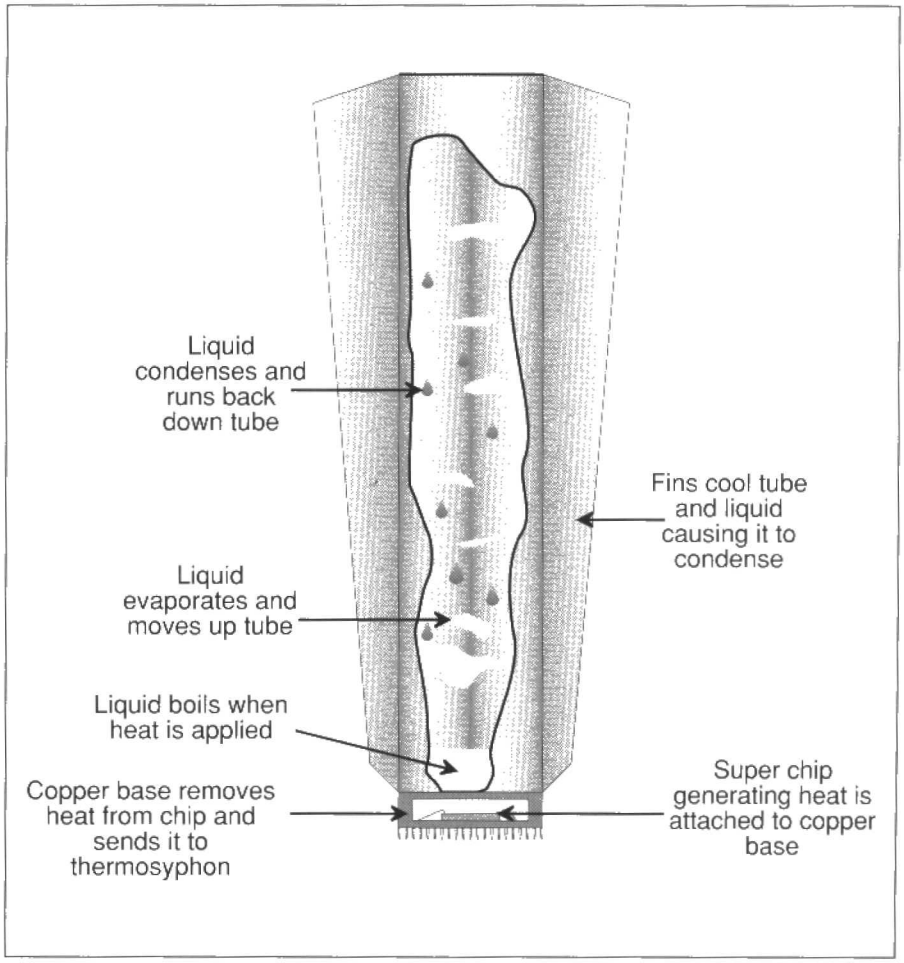
To add a third layer would enable many more gates to be connected but would incur a significant cost penalty. Unfortunately using only two layers seriously limits the gate usage to between 40% and 50 %.

One solution to this problem has been developed at S-MOS Systems in San José, California. Its new cell layout uses an interleaved gate structure instead of the straight line gates which have been used previously.

The 'E' shaped gates interleave with one another giving the advantage of more contact points for the two connection layers. With the new system, routing is vastly simplified and more of the gates in the structure can be used. It is hoped that gate utilisation of 80% to 90% can be achieved in many cases.

The new structure has already been used in evaluation samples to assess the gate usage. As expected efficiencies in excess of 80% have been achieved. This also has a cost benefit in that smaller chip sizes can be used.

S-MOS is incorporating the new technique into a new family of gate arrays which should be available for use in electronic systems in the near future. The circuits will use a 0.8 µm C-MOS process and initial gate arrays will contain up to 120k gates.

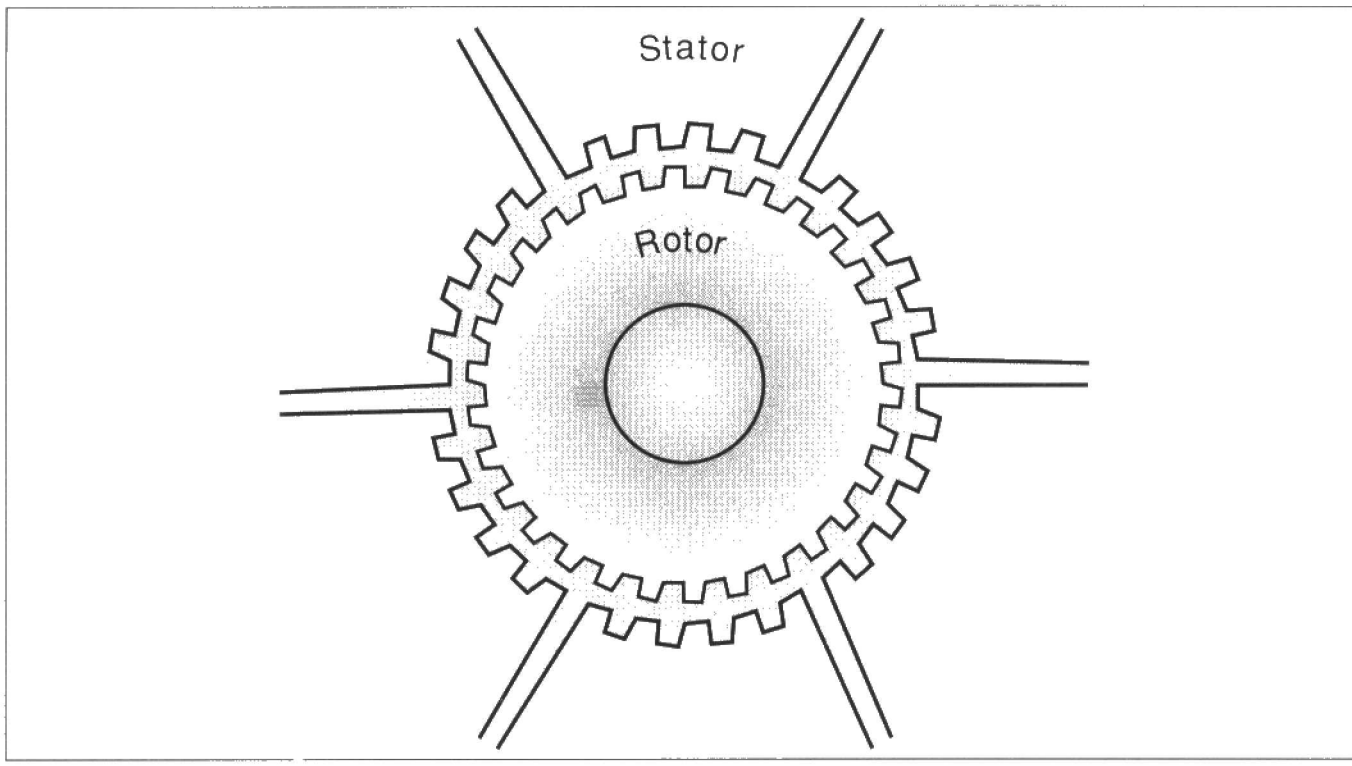


Running Cool

With the steady advances in IC technology, chips are becoming faster, more complicated and much larger. One result of this is that the heat generated by the chips is becoming an increasing problem for designers. In fact correct IC packaging is becoming critical and new ways are being sought to remove heat from ICs before any new designs run into trouble. This will then open the way for super sized ICs which are expected to arrive in the very near future.

As part of a development programme to meet the future demands, engineers at Digital Equipment Corporation in California are investigating new cooling methods. One technique being used to evaluate their effectiveness is infra-red imaging.

To simulate the super IC of the future a silicon film resistor is used as a heater. This is placed on a plastic pin grid array and used to test various cooling methods in an effort to assess their effectiveness.



The advantage is that this can be done before any new ICs are even designed.

Current cooling techniques under investigation involve forms of liquid cooling. The heat generated in the simulated chip is transferred onto a metallic layer attached to the base. Copper has been chosen for this in view of its high thermal conductivity and relatively low cost.

The copper base is attached to the end of a thermosyphon. This consists of a finned copper tube about 20 cms long and 4 cms in diameter. Inside the tube there is a liquid under partial vacuum.

In a thermosyphon heat from the IC enters the copper base and moves to one end of the tube. Here it heats the liquid which boils removing heat from that area. Air passing over the outside cools the pipe and causes the vapour to condense. Having cooled the liquid falls back down the pipe to repeat the cycle.

Whilst the basic principle operates very well it has to be optimised to a very high degree. As a result, accurate remote sensing is needed to assess every part of the chip. This is needed because it has been found that even very small changes in temperature can affect the operation of some ICs.

Infrared thermal imaging has provided the solution for these heat measurements. It has provided the data enabling engineers to be able to analyse exactly what is happening in the IC. It has helped solve a number of problems and enabled tomorrow's technology come a little nearer.

Microscopic Motors

There is a growing need for ultra-miniature motors of less than 1mm in diameter. Applications can be found in a number of areas including medical electronics, robotics and a number of specialised measuring systems.

Until recently it was only possible to make motors of very small size in a relatively flat shape having little power. Now a new technique, developed at Karlsruhe Institute of Technology, has enabled motors several micrometers high to be made which can develop relatively large forces.

The motors use voltages of up to 100V on the stator to produce the required field. Both the rotor and the stator have teeth cut into them as shown above. This increases the electrostatic attraction which in turn increases the torque. Currently these motors are able to develop sufficient torque to be able to reliably reach speeds of 50 rps (revolutions per second).

The key to the manufacture of these motors is a deep etch synchroton lithography process used in conjunction with electroforming and specialised plastic micro-moulding techniques. The whole process allows for the manufacture of structures with heights of several hundred μm which can be accomplished whilst still retaining lateral accuracies of about 1μm.

A number of stages have to be used in the process. The first is to deposit a layer of silver on an insulating substrate (base layer). Later this silver is used to provide the contacts.

The next stage is to add a layer of titanium a few micrometers thick. It gives good adhesion and it is used as the foundation for further layers added later. However, before any further layers are added the titanium is etched using standard photolithography techniques.

Once this has been accomplished a resist layer is polymerized onto the substrate and exposed to synchroton radiation through an X-ray mask. This has to be very precisely positioned to match the pattern of the titanium layer. The reason for this is that it adjusts the position of the movable parts of the structure which are formed on top of the titanium. The fixed parts are placed on the metallised areas of the substrate.

The irradiated resist is removed and then a metal is electro-deposited. After the removal of the resist the titanium is selectively etched using hydrofluoric acid. When the process is complete some parts of the structure remain attached to the substrate whilst others can move freely.

Development is still in progress and in their existing form the motors are not very easy to use. However, it is hoped that the next stages of the development will overcome most of these problems . When the motors are finally ready they will open up a whole new area of micro-miniature electromechanical engineering with a wide variety of applications. ■

MX9000 Multi Instrument

Peter Stewart hooks up an all in one PSU, waveform generator, frequency counter and DMM.

Anyone who is interested in constructional electronics as a hobby or is a professional electronics engineer will know that there are some test instruments needed for even the most basic circuits. Most people can get away with a simple multimeter able to measure voltage, current and resistance. Perhaps the next most useful instrument is a bench power supply. Other possibilities include a frequency generator, frequency counter and an oscilloscope.

The MX9000 combines four of the major bench instruments in one case with a single power supply and integrated display panel. Gone are the days of having a number of instruments spread around the workbench with wires trailing everywhere and multi-way power sockets to drive them.

In the MX9000 are a triple output power supply, a frequency counter, waveform generator and digital multimeter (DMM). The device also comes with a pair of test leads for the DMM, an input/output lead for the frequency counter or waveform generator and a manual. There are no leads for the power supply but the banana connectors are fairly standard and it should be possible to make them up with little trouble.

Only one mains power lead needs to be plugged into the MX9000. A single power switch on the front turns all of the instruments on and is conveniently placed so that it can be switched off quickly. Perhaps the only problem with the system is its size. Using a similar type of case to a small PCAT personal computer, it will take up a lot of room on a crowded workbench. On the other hand, so will four individual instruments.

On the bottom of the case, two fold out feet are available for tilting so that the readouts can be seen more clearly. All of the controls are easily accessible and the positioning of the connectors means that tangles of wiring should be kept to a minimum.

On the left of the MX9000 is the power supply with its readout at the top. On a button press, this can display either volts or amps but not both. Three outputs are provided, 5V 2A, 15V 1A and a variable 0-50V with current supply up to 500mA. Current

limiting is supplied and a cutout comes into effect if an overload occurs.

The variable voltage output is adjusted with a multi-turn knob and it is possible to obtain an accuracy of about 0.1V. The supply voltage seems quite stable over long periods of time and the meter readings were easy to see.

On the right hand side of the instrument, the DMM display was not quite so clear. At angles other than directly facing it, the LCD was rather confused. Recessing it or providing a back-light would have improved things somewhat.

The DMM itself is of fairly standard format with the usual voltage (AC/DC from 100µV to 1100V in five ranges), current (AC/DC 10µA to 10M in two ranges) and resistance (0.1Ω to 100MΩ in five ranges) measurements possible. Memory and memory difference plus hold functions are provided as well as separate inputs for high, low current and voltage/resistance.

The frequency counter section also has problems with its readout. Unlike the other two displays, this is made up from red, seven segment LEDs which are rather small and dim. No provision for interval measurement is provided but the ability to count from 1Hz to 100MHz is adequate on the frequency side of things. Three gate or sample times are provided, 10s, 1s, 100ms and 10ms allowing different accuracies to be traded with speed of update – an LED indicates when the gating is in progress. Two ranges, 10MHz and 100MHz,are available to provide greater accuracy at lower frequencies. At the press of a button, the display can be used to show the frequency output of the function generator.

Probably the most sophisticated section of the MX9000 is the function or waveform generator. This provides sine, square and triangle outputs which, with the aid of offset and symmetry controls, can be changed to give skewed sine, variable pulse width and ramps. Output frequencies are from 0.02Hz to 2MHz controllable from one of seven range switches and a dial. It is also possible to vary the output frequency with a linear or logarithmic ramp waveform with full depth control – this can also be manipulated with an external voltage.

Outputs are either 50Ω or 600Ω with full amplitude control to attenuate by up to 20db, or TTL for which a separate output is provided.

Conclusion

Priced at £360+VAT, the MX9000 represents relatively good value for money when compared to buying the equivalent individual instruments. The only real problems seem to lie with the frequency and DMM displays. Apart from these, the MX9000 is well worth considering if you are setting up a workshop.

The MX9000 is available from Saje Electronics 117 Lovell Road, Cambridge, CB4 2QW, Tel 0223 425440, Fax 0223 424711 ■

Putting The Telephone In Control

Richard B Sagar describes how to use touch tones to send commands down the telephone. This decoder can be used to control equipment anywhere there is a phone.

Anybody who has had a new phone delivered recently, or has seen a BT advert on TV for call waiting, will probably now be connected to a digital telephone exchange. If you don't know for sure, one way to tell is if your phone "beeps" when you dial. Phones on digital exchanges use these beeps to signal to the exchange the numbers dialled. For each key pressed there is a unique pair of tones from the set of eight available – the signalling method is therefore called Dual Tone Multiple Frequency (DTMF).

If you have ever leant on the buttons of the phone during a call you will know that, firstly, the tones are still active during the call and, secondly, no detrimental effect on the call occurs (bar a slight deafening of the person at the other end). It is these two features that make DTMF signalling useful for accessing services such as remote banking.

This project makes use of DTMF codes to switch equipment remotely over a telephone. This is not necessarily limited to telephone lines, for instance ham radio users could utilise the circuit to control a repeater station via the radio, turning it on or off or changing its channel. In practice, using the unit with the telephone introduces a problem as direct connection of unlicensed equipment to a BT line is prohibited. However, a way around this is to use an answering machine. By connecting a microphone to the circuit input and positioning it close to the monitor loudspeaker of the answering machine the tones can be picked up. A magnetic pickup gives good results and gets around the problem of acoustic interference.

How It Works

The design offers a good level of security against any would be 'hackers'. Before any DTMF codes are passed on for device control an 8 digit access code must be entered. The code needs to be programmed when the power is switched on and it is then stored in RAM. In use the same code is entered first with any subsequent digits being output to the user port for further decoding. To access the unit from a non-DTMF phone a DTMF keypad can be used, these can be bought for around £5 and in some cases come

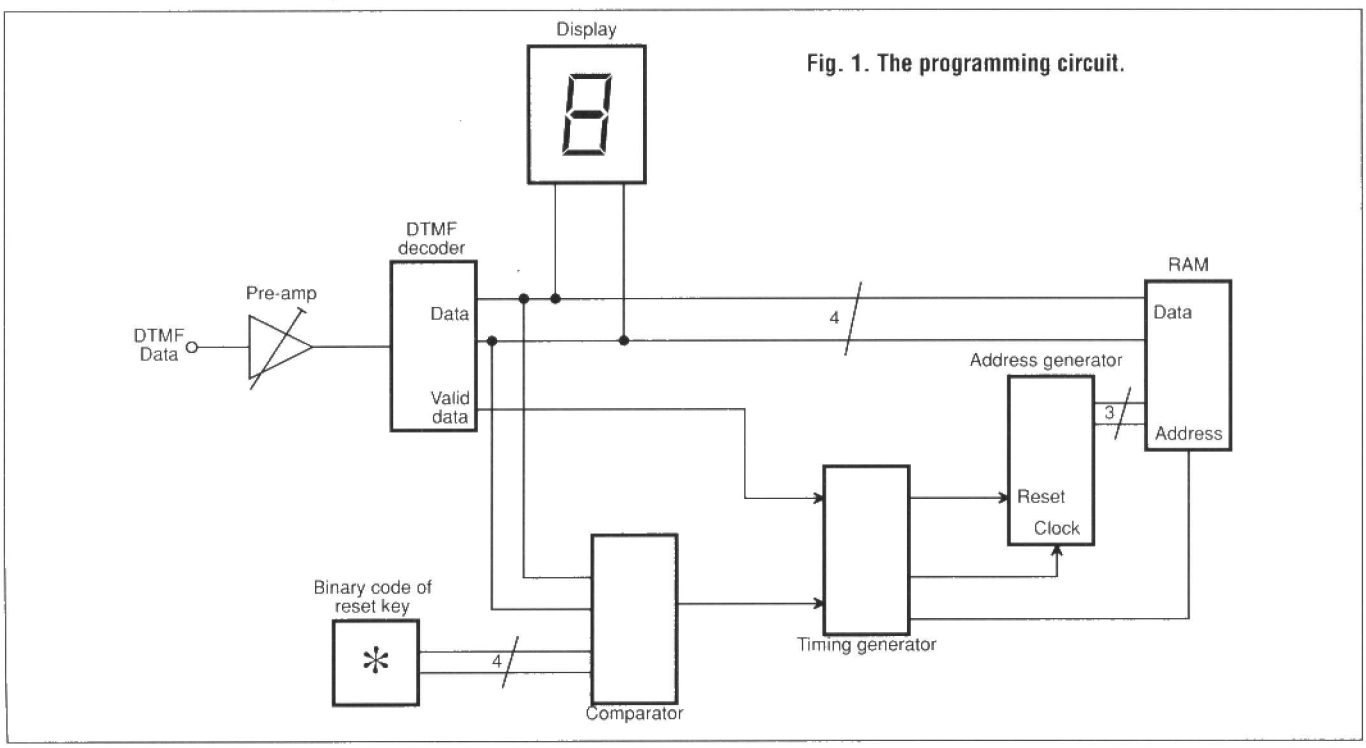


Fig. 1. The programming circuit.

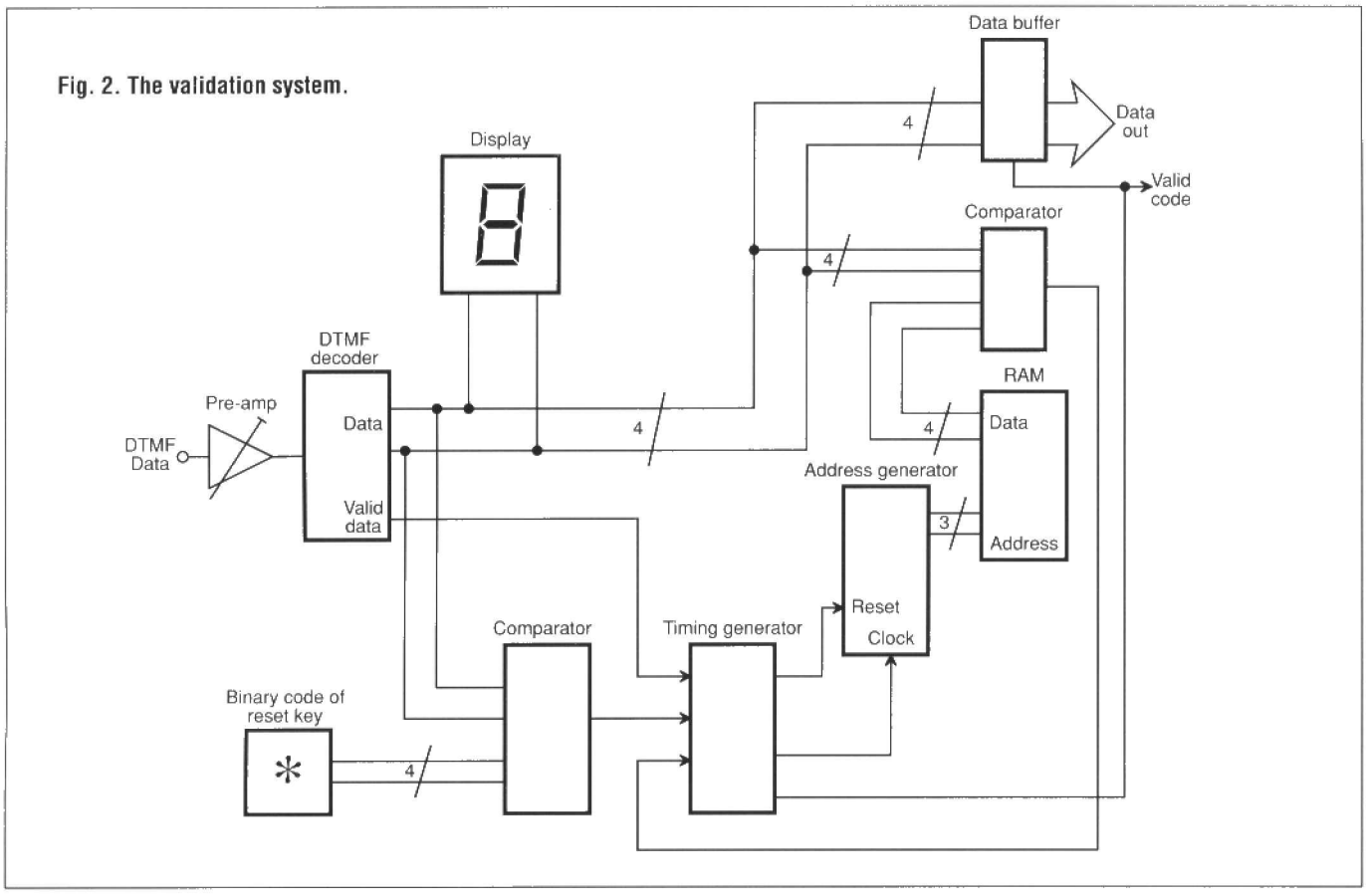


Fig. 2. The validation system.

with a ten number memory. Needless to say it isn't worth trying to make your own, for that price you wouldn't be able to buy the box to keep it in. During programming the same keypad is used, held in front of the microphone and the code typed in. After use the unit is put back into the code entry phase by the user pressing the '*' key on the key pad, or if this doesn't occur it will automatically time-out after approximately one minute, helping to prevent any unauthorised access. The '*' key is also used in the programming stage, to indicate that the access code is about to be entered, this allows the user to re– start if a typing error was made. Bearing this in mind the '*' should not be used for any control functions or included in the access code.

Basic Operation

Operation falls into two phases, programming and validation. During programming a circuit configuration of that in Fig. 1 is needed, with the data output from the DTMF decoder feeding the input of the RAM for storage. The timing decoder will determine the sequence for writing data. For validation the circuit of Fig. 2 is needed so that the RAM contents and the digit being entered can be compared. The timing block now has to take into consideration the comparison of the stored and entered digits and only allow the address to increment when the two are equal, the VALID output can only go high when all 8 digits have been entered in the correct sequence.

The Electronics

The decoding of the DTMF signals is performed by IC2. The input can be taken directly from the microphone as the chip contains its own pre-amp circuit. The ratio R1/R2 sets the pre-amp gain and this may need to be changed depending on the sensitivity of the microphone used. The amplified signal level at pin 3 of IC2 needs to be set between 61mV and 2.4V for correct decoding. When a valid DTMF pair is detected the corresponding number is output on Q1-Q4 and the SID output goes high, remaining high until the input is removed. The crystal is required to produce a clock of the high accuracy needed for this application. Though the frequency may seem a little strange it is quite a standard crystal used for the colour sub-carrier frequency in NTSC televisions as used in the USA and Japan.

During the programming phase the received digits are routed to the RAM data bus through IC6 the tri-state buffer. To allow this the $\overline{\text{PROG}}$ input is taken low. The WRITE ENABLE and the timing decoding block (the circuit around IC's 4 and 7) are also connected to this input to set the RAM in WRITE mode and allow the data to be latched at the correct time. The address of the RAM is set by IC9, a 4 bit counter. As Fig. 3 shows, a reset on this chip can be caused by the output of IC1 or IC5. IC1 detects the reset key (*) being pressed and so allows code entry to be restarted, IC5 is used during the verification phase. When eight digits of code have been entered the output of IC10, the monostable, will go high, opening the data bus, to set the unit into the validation mode $\overline{\text{PROG}}$ is taken high. The data bus can then be turned off by pressing the '*' key on the keypad.

Easy Access

For verification of the access code IC3 compares a digit of the code stored in RAM with the data entered over the channel. The out-

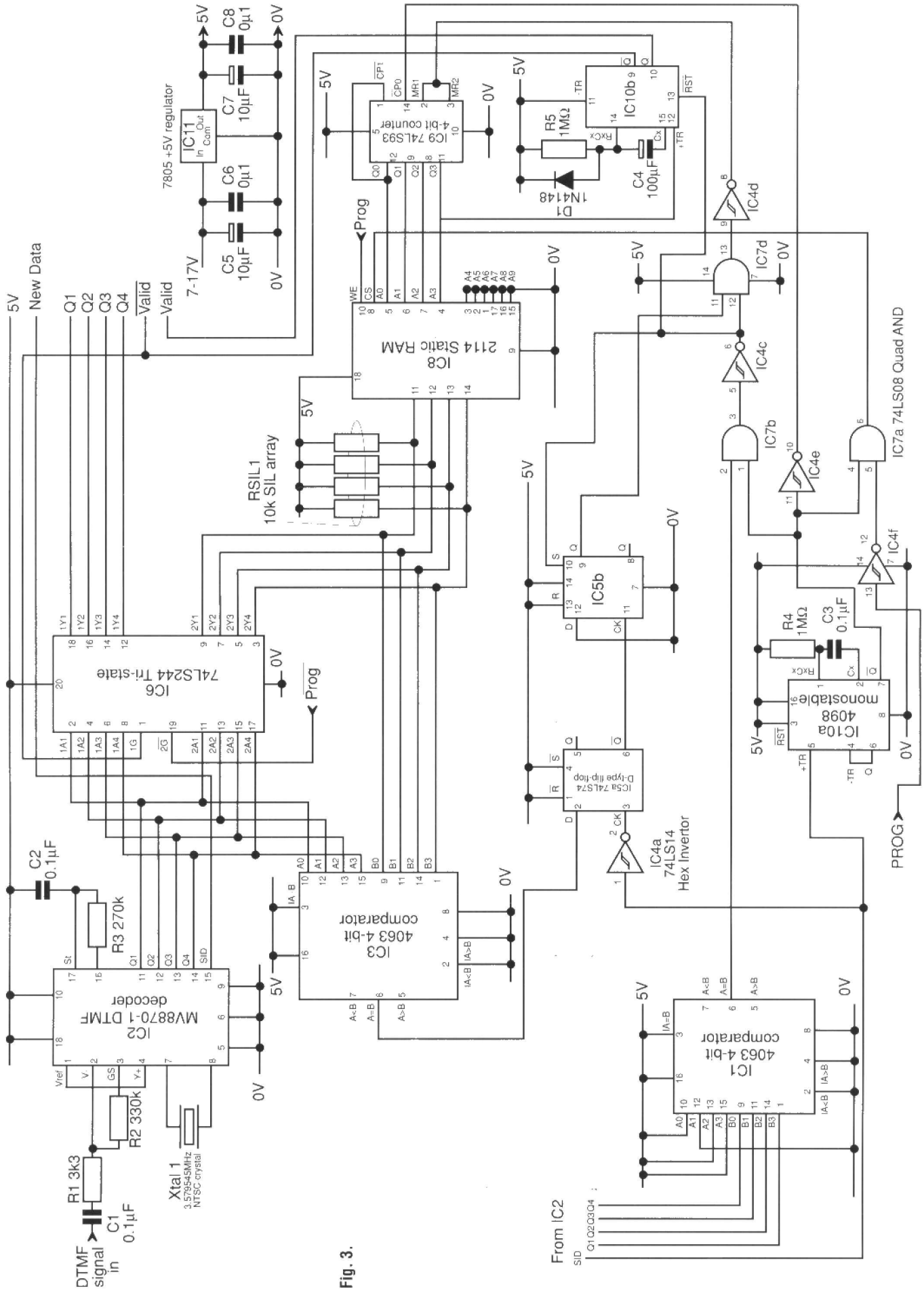

7805 +5V regulator
IC11
C8 0µ1
C7 10µF
C6 0µ1
C5 10µF
7-17V
5V
0V
New Data
Q1
Q2
Q3
Q4
Valid
Prog
IC9 74LS93 4-bit counter
IC10b
R5 1MΩ
C4 100µF
1N4148
D1
IC4d
IC7d
IC4c
IC7b
IC4e
IC7a 74LS08 Quad AND
IC4f
IC8 2114 Static RAM
RSIL1 10k SIL array
IC6 74LS244 Tri-state
IC5b
IC5a 74LS74 D-type flip-flop
IC4a 74LS14 Hex Invertor
IC10a 4098 monostable
R4 1MΩ
C3 0.1µF
PROG
C2 0.1µF
R3 270k
IC2 MV8870-1 DTMF decoder
IC3 4063 4-bit comparator
IC1 4063 4-bit comparator
R1 3k3
C1 0.1µF
R2 330k
Xtal 1
3.579545MHz NTSC crystal
DTMF signal in
From IC2
SID

Fig. 3.

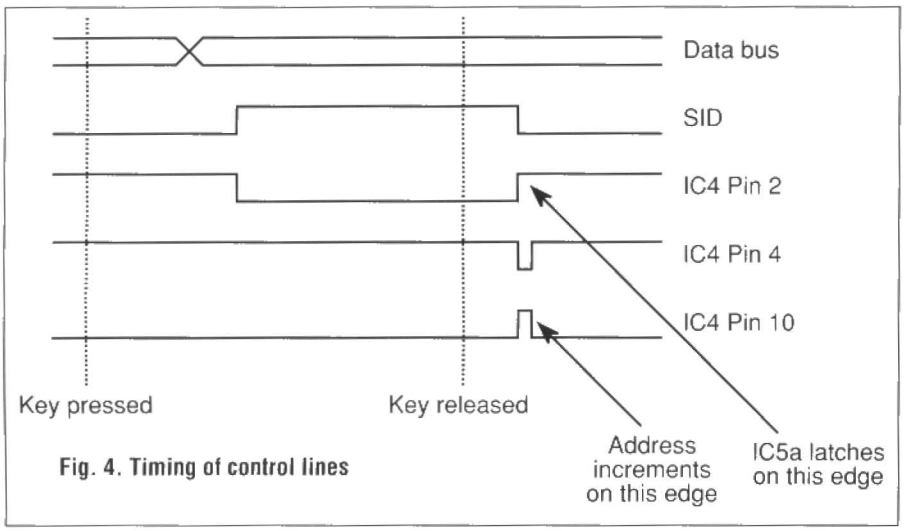


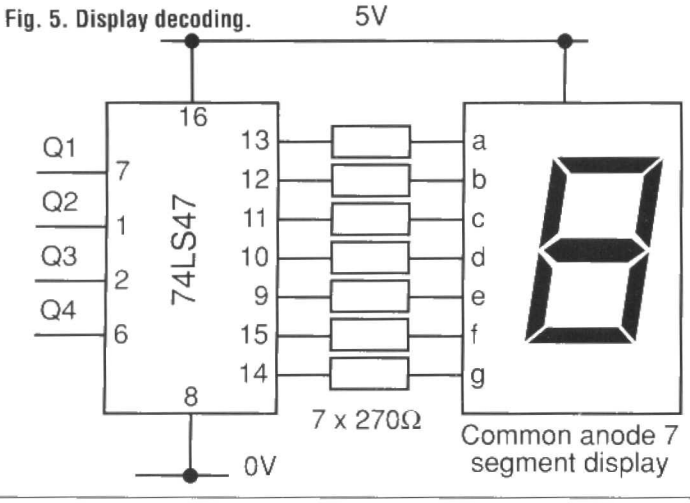
Fig. 4. Timing of control lines

put of IC3 is latched by IC5a when the key is released. When a difference in the two digits is detected the $\overline{Q}$ output of IC5(a) will go high, causing a low to be latched into IC5(b). The low at IC5(b)'s output will then reset the address counter for the RAM and so the VALID output will be prevented from going high. The output of IC5(b) must be SET high again which is done by pressing the '*' key – this should make it more difficult for anybody to 'stumble' across the correct code.

Fig 4 shows the sequence of data on the control lines when a key is pressed. IC4(b), C3 and R4 act as a monostable and the short pulse produced by IC4(b) is used for strobing the SELECT line of the RAM, in programming mode, to cause the data on the bus to be latched. As the strobe pulse occurs on the falling edge of the SID output of IC2 the data is sure to be stable on the bus. The rising edge of this pulse, after inversion by IC4(e), increments the RAM address on IC9, ready for the next number to be stored. During validation the $\overline{CS}$ line of the RAM does not need to be strobed and so the line is held permanently low when the PROG line goes high, via IC4(f) and IC7a. IC5(a) is used to latch the output of the comparator just as the key is released, this prevents an incorrect reset pulse being produced by IC3 when the RAM address is incremented and the input from the user is being waited for.

The four bit output on the user port can now be decoded as required. If ten separate control lines are required (for example 0-9) then this can be done simply by connecting a 74LS164 on the output bus and using the VALID line to control its ENABLE input. It is important to remember that the '0' button actually produces the number ten at the output (1010 in binary), not a zero. The display suggested in figures (1) and (2) is provided using the circuit in Fig 5), though because of the point just mentioned the output will not be meaningful when zero is entered, nor '*' and '#'.

Fig. 5. Display decoding.



Components

Resistors

R1	3.3kΩ
R2	330kΩ
R3	270kΩ
R4	1MΩ
R5	1MΩ
RSIL1	10 SIL resistor array

Capacitors

C1	0.1µF
C2	0.1µF
C3	0.1µF
C4	100µF Electrolytic
C5	10µF Electrolytic
C6	0.1µF
C7	10µF Electrolytic
C8	0.1µF

Semiconductors

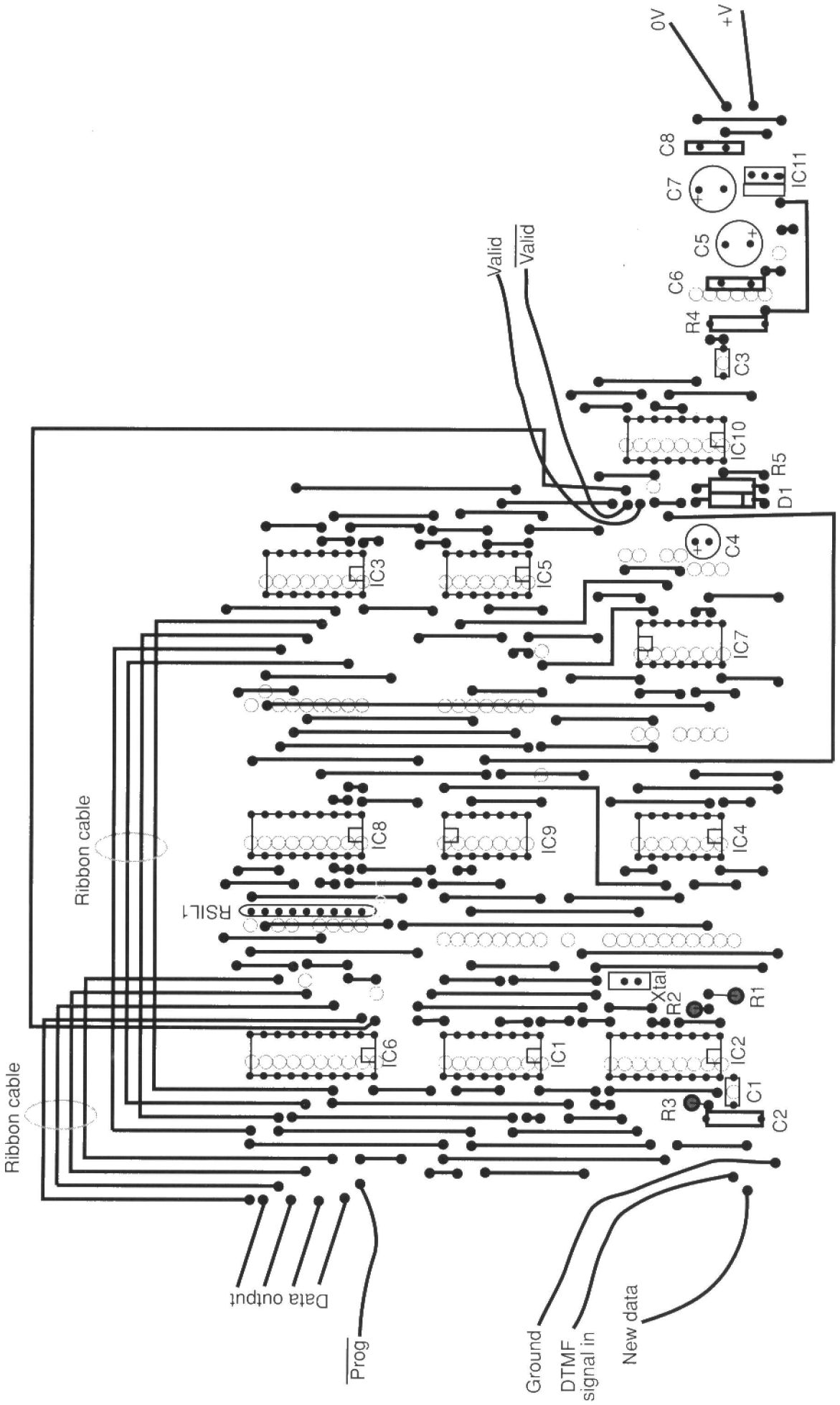
IC1	4063 – 4-bit comparator
IC2	MV8870-1 – DTMF decoder
IC3	4063 – 40-bit comparator
IC4	74LS14 – Hex invertor
IC5	74LS74 – Dual D-type flip-flop
IC6	74LS244 – Tri-state buffer
IC7	74LS08 – Quad AND
IC8	2114 – Static RAM
IC9	74LS93 – 4-bit counter
IC10	74LS93 – 4-bit counter
IC11	7805 – +5V regulator

Miscellaneous

3.579545MHz NTSC Crystal
Cheap microphone or magnetic telephone pick-up
43 strips x 80 holes stripboard
Mains power adaptor delivering from 7V to 17V DC at at least 150mA

Construction

The circuit can be built on a piece of Veroboard of 43 strips width by 80 holes. Power supply decoupling capacitors should be provided for each chip of 0.1µF. The power supply into the regulator can be between 7V and 17VDC and if the answering machine used with the circuit has an external transformer, as most do, this should be able to power both this board and the answering machine (the board requires around 150mA current). The DTMF decoder is the only part not widely available. This was bought through ESD Electronic Services – Tel. (0279) 626777, part No. 91320E. ■



Stripboard layout.

Techniques

Andrew Armstrong explains how perpetual motion can't work in electronic circuits.

This month we have an enquiry from Michael Harkess of Christchurch, New Zealand, who wonders if he has discovered the electrical equivalent of perpetual motion. He asks "I write to you in the hope that you can help me decide if this simple idea works and, if it doesn't, why not.

When a series resonant circuit (Fig. 1) is connected to a source of signal at the resonant frequency, the peak voltage on the capacitor exceeds the peak voltage on the input. Suppose that at this moment the capacitor were disconnected from the resonant circuit and instead connected to a load. The load would now be receiving more voltage than the peak applied to the circuit, which appears to have created more energy than was applied in the first place. The only argument against this is that a high Q resonant circuit requires many cycles to reach such a high peak voltage, and the energy dissipated in reaching this might defeat the object.

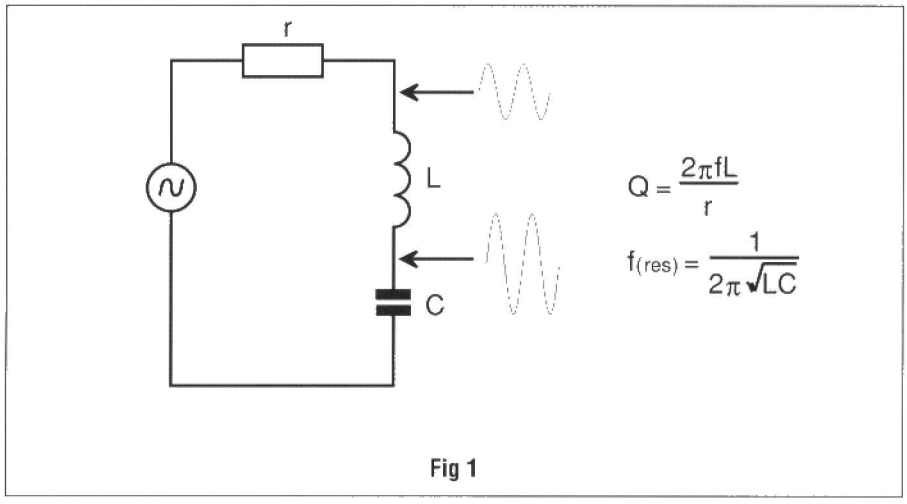


Fig 1

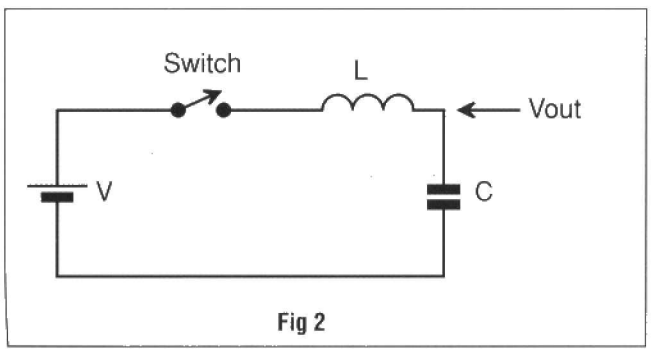


Fig 2

As an alternative, simply consider what happens when a DC source is connected to the circuit. The junction of the capacitor and the inductor will ring (at least on the first half cycle) to a higher voltage than the DC input.

If the capacitor is disconnected at this peak, then there is definitely more voltage than that applied to the input and, because only half a cycle of ringing has taken place, the dissipation must be minimal. Strange as this idea might seem, it remains true that the charge, and therefore the power, developed on the capacitor, is enormous, and it seems that there must be some way to access this energy.

I'm sorry to say that this idea cannot be used to generate more energy than was first applied, tempting though it sounds. The easy way to deduce this is simply that the laws of physics have never allowed for what is effectively perpetual motion.

However, that is not in itself a satisfying rebuttal of what appears to be an attractive idea, so instead I will attempt to analyse what really happens in this case. As an aside, though a resonant circuit does not create energy, it is not absolutely impossible that one day some obscure loophole in the currently understood laws of physics will permit the creation of mass/energy. After all, the universe exists, and this may be taken to imply that more of the same could be made to come into existence.

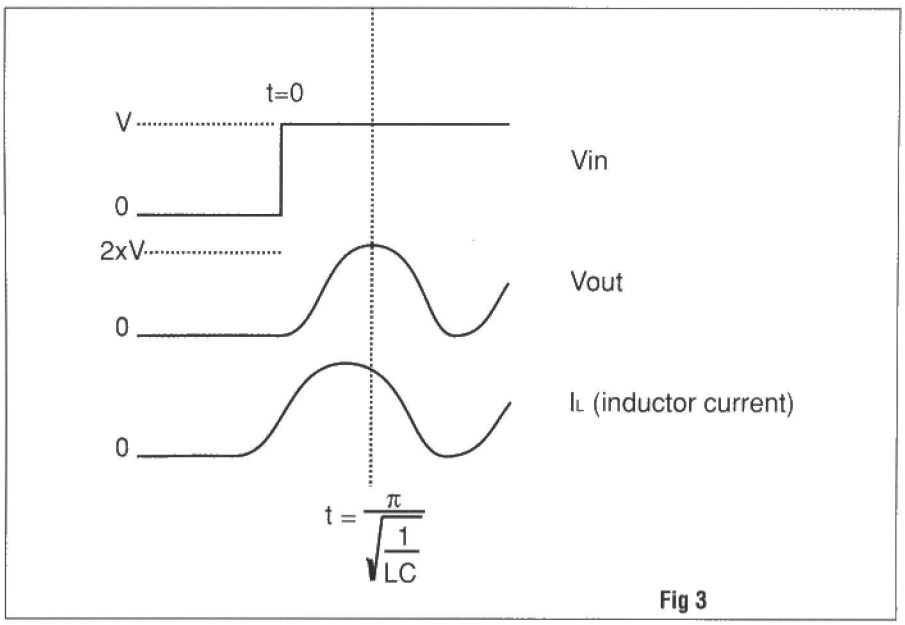


Fig 3

Output voltage as a function of time $V(t) = V \times \mathcal{L}^{-1}\left[\frac{1}{s} \times \frac{\frac{1}{SC}}{SL+\frac{1}{SC}}\right]$ ①

(Unit step function)

$= V \times \mathcal{L}^{-1}\left[\frac{1}{s} \times \frac{1}{s^2LC+1}\right]$ ②

$= V \times \mathcal{L}^{-1}\left[\frac{1}{s\left(s^2+\frac{1}{LC}\right)LC}\right]$ ③

$= V \times \mathcal{L}^{-1}\left[\frac{1}{s\left(s^2+\frac{1}{LC}\right)LC}\right]$ ④ ← This is of the standard form: $V \times \mathcal{L}^{-1}\frac{\omega^2}{s\left(s^2+\omega^2\right)} = 1-\cos(\omega t)$

$\Rightarrow V(t) = 1-\cos\left(\sqrt{\frac{1}{LC}}t\right)$ ⑤

Maths 1

Stored energy in a capacitor $= \frac{1}{2}CV^2$

The voltage in the capacitor at $t = \frac{\pi}{\sqrt{\frac{1}{LC}}}$ is 2V

Maths 2

So: Energy $= \frac{1}{2}CV2^2 = \underline{2CV}$

$I_L = I_t = C\frac{dv}{dt} = C\frac{d\left[1-\cos\left(\sqrt{\frac{1}{LC}}t\right)\right]}{dt}$

$= -C\sqrt{\frac{1}{LC}}\sin\left(\sqrt{\frac{1}{LC}}t\right)$

Maths 3

Voltage Waveform

For an example, we will use the circuit shown in Fig. 2. In this thought experiment, a voltage V is applied to the LC circuit at time t=0. When the switch is closed, current starts to flow in the inductor, and the capacitor starts to charge. Clearly, the stored energy in the capacitor depends upon the voltage across it, so the first thing to do is to discover what the capacitor voltage is as a function of time.

There are several approaches to this. The one chosen here is to use Laplace transforms, which are a good mathematical tool to investigate the time, rather than the frequency response, of circuits. The first line of Maths 1 is saying that the output voltage as a function of time is equal to the input voltage multiplied by the inverse Laplace transform of the unit step function multiplied by the potential divider action of C and L.

The unit step function, 1/s, is 0 until t=0, and then is 1. This represents the switch being switched on at t=0. In transform terms, the impedance of a capacitor is given by 1/sC, and the inductance by sL. The second bit of this equation is the generalised impedance equivalent of R2/(R1+R2).

It is intuitively obvious that an oscillatory waveform will result, so in lines 2,3 and 4, the right-hand part of the equation is progressively converted into a standard form whose inverse transform is oscillatory. Unsurprisingly, the answer in line 5 is a cosine waveform with an offset. The waveforms are illustrated in Fig. 3.

Energy drawn from power source $= \int_0^T VIdt$

$= V\int_0^{\frac{\pi}{\sqrt{\frac{1}{LC}}}} -t\sqrt{\frac{1}{LC}}\sin\left(\sqrt{\frac{1}{LC}}t\right)dt$

Maths 4

$= +CV\sqrt{\frac{1}{LC}}\sqrt{LC}\left[\cos\left(\sqrt{\frac{1}{LC}}t\right)\right]_0^{\frac{\pi}{\sqrt{\frac{1}{LC}}}}$

$= CV[\cos 0 - \cos\pi] = \underline{2CV}$

Energy Balance

The peak stored energy occurs when the capacitor voltage is at its maximum, and the inductor current is zero. This occurs at the time shown by the equation in Fig. 3. The stored energy on the capacitor can now be calculated as shown in Maths 2, and it is equal to 2CV. Conservation tells us that the energy drawn from the power supply must be the same, assuming that there are no losses. To check this, we can calculate the power by integrating voltage and current over the time period from zero to the dotted line in Fig. 3.

The voltage is constant, but it is necessary to calculate the current. One approach would be to do a whole new inverse Laplace calculation using equations for inductor current, but because we already know the capacitor voltage waveform, we can use this fact to determine what the current must be, as shown in Maths 3.

In Maths 4, this is integrated over the requisite time period, and does indeed produce the answer 2CV.

What this goes to show, is that the energy stored on the capacitor is exactly equal to the power supply, despite the fact that the capacitor voltage is double the input voltage. If this goes counter to intuition, remember that as soon as a load is connected to a capacitor, the voltage starts to fall, while, if a load is connected to the power source, current will flow continuously. In this case, the inductor current continues to rise until the capacitor voltage equals the input voltage. After this point, the inductor current declines for an equal period, and, by symmetry, the capacitor voltage must be double the input voltage.

I apologise to those who do not like maths: neither do I, but occasionally it is unavoidable. I have made use of tables of standard Laplace transforms and integrals and differentials to minimise the amount of detail required. ■

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